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Liquid Gas.

By NISBET LATTA.

A very active development in this country at the present time is the preparation for the manufacture of "Liquid Gas." This may have a very interesting bearing upon the entire gas industry, as well as upon many other industries dependent upon the production of heat. It must be understood in the predication of the forthcoming article that it is not the idea of "Liquid Gas" to interfere with or supercede any present installation in our existing gas plants; but, as far as the gas-lighting industry is concerned, it is to occupy a new and virgin field, namely, that of small towns, isolated communities, farms (which are particularly a valuable market) and other locations which do not justify the service of segregated plants or even the extension of high-pressure mains. In no way will it interfere with vested interests.

This fact being clearly developed, the writer proceeds to sketch as briefly as possible the principles upon which "Liquid Gas" is based. Primarily, we desire to differentiate the "Liquid Gas" herein discussed from Blaugas and Pintsch gas: These having as eminent source a distillation of liquid hydro-carbons by heat, while the other oduced by fractional distillation and disruption of natural gas due to compression, the distillation occurring upon a progression or projection of the well-known principle in vogue for the extraction of gasoline from natural gas. This, however, being a multi-stage operation, the principle products of which are butane, propane and ethane, which liquifies at a pressure of less than 700 pounds per square inch, a pressure both mechanically and commercially practical. The fractions butane, ethane, and propane having been removed during multi-stage compression in a manner analagous to the extraction of gasoline, may be separated and segregated as a system of condensates, leaving each element in a very pure condition. The gas used is the so-called "wet gas" that issues from practically all oil wells and many gas wells. The average production will probably be from 35 to 55 pounds of liquid per 1,000 cubic feet of gas. This gas can be obtained for less than 5 cents per 1,000 cubic feet. The weight of liquid gas is about four pounds to the gallon. Each pound produces 124 cubic feet. Each square foot of container contains 100 cubic feet of gas, the ratio of reduction being 100 to 1.

The present steel container carries 1 pound of liquid for each pound of its own weight, although it is more than likely that the weight of this container will be materially reduced, so that 75 pounds of container will hold 100 pounds of liquid.

The liquid, either in small lots or in bulk, can be safely and economically transported in steel containers, for which the average charge, in small lots, will be about 6c. to 8c. per 100 miles per 100 pounds of liquid; and in bulk about one-half of this amount. Tank or tube cars can be built to contain liquefied product equivalent to about one million cubic feet of gas. The car will be delivered to a side track, near which will be placed a distributing tank or holder similar to those used for artificial gas. Into this gasometer the liquefied natural gas will be discharged in the form of gas into which it expands when the pressure is released through the opening of a valve on the container. From the holder the gas may be distributed at low pressure through mains, the same as with ordinary city gas.

The calorific power of these concentrates make them much more valuable than ordinary gas, and it should command a higher price. The process of manufacture is simple and entirely practicable and under proper conditions should not cost over ¼c. per pound of liquid.

There are two matters of special interest in the investigation of this system. The first being as follows:

The fractions in which we are principally interested, are homogeneous gases of constant quality and not subject to fluctuations in candle power, heat units or chemical analysis, as are all so-called artificial gases. This spells a very important thing, namely, that Welsbach service, that is to say incandescent mantles, would be increased in efficiency. The maintenance of, for instance, gas arcs will be reduced to a minimum. Lights and heaters could operate continuously for indefinite periods without attention, while there would be no fluctuations in the value of their service. Another very important phase is in the re-transformation of the liquid into a gas. Upon its effluence from the container a strong refrigerating action occurs from the absorption of heat due to re-expansion. This refrigerator action tends to dampen or control the rate of flame propagation, hence the combustion is steady and even, and the result is a fuel rather than an explosive. This action can also be utilized for cooling purposes in domestic installations by carrying a coil of pipe through existing refrigerators.

Reverting to the previous distinction made between "Liquid Gas" and gas of the Blau and Pintsch type, the writer desires to emphasize that, while the latter two gases are the product of fractional distilla-

tion at relatively low temperatures, due to the action of heat upon hydro-carbons, the former is distilled (perhaps a better word is fractionated) through the medium of pressure and, of course, by the action of the heat developed by the pressure. The function performed is dual. Any engineer experienced in the operation of heavy-duty gas engines knows that there is a material difference in the analysis of the gas within an engine cylinder during various stages of the compression stroke. This is doubtless due to a molecular rearrange ment due to the pressure, the heat generated also having a disruptive effect upon the componnds and a cementive or fusing effect upon the new-born molecules. In the case of the liquifaction of natural gas, the practical operation of the plant varies of course with the quality of the gas handled — its "wetness," its analysis and atmospheric temperature — conditions varying considerably between winter and summer. Take, however, an average with a varient of 10 to 15 per cent. The multi-stage compression already referred to is as follows, the condensed liquid at each stage being drawn off at the critical temperature and pressure:

Compression, 1....	150 to 200 pounds,		Hexane and Water liquified
" 2....	300 to 350	"	Butane liquified
" 3....	500 to 550	"	Propane "
" 4....	800 to 850	"	Ethane "

There is a reverse method, which has also proved successful, namely, the compression of the entire gas to 1,000 pounds, and a system of progressive condensation and release, the operation of which is as follows:

Operation

1.... Compress natural gas to 1,000 pounds at temperature of steam (212° F.) eliminates water and hexane.
2.... Cool with hot water 120° F. eliminates butane.
3.... " " 65° cold water " probane.
4.... " " 40° F. " ethane.

It is understood, of course, that the compressed gas is put into containers, which are jacked with condensing mediums of the temperatures indicated, the condensates being removed at their critical temperature, and there remains a small quantity of methane, but as this only liquefies at 2,250 lbs., it is not expedient to condense it. It is, therefore, disregarded and is usually returned to the gas mains, or may be used for some local purpose.

The power required to compress natural gas or any of its constituents from one pressure to another, depends only upon the amount of gas, expressed in millions of cubic feet of free gas per 24 hours. on the number of compressions and on the initial temperature; but is independent of the actual initial and terminal pressures of the gas. This is to say that the same amount of power will be required to compress one million cubic feet of free gas, measured at 14.65 pounds absolute pressure and 60° F. in 24 hours from atmospheric pressure to an absolute pressure of 29.3 pounds (two compressions), as from say 315 pounds to 630 absolute pressure, the initial temperature being the same in both cases (60° F).

Noting the diagram (Fig. 1) the curve marked "Isothermal" gives the amount of power required to compress one million cubic feet of natural gas in 24 hours, measured at atmospheric pressure (14.65 pounds per square inch) and 60° F. assuming that the temperature is kept constant, the heat generated by the compression being extracted as produced. The curve marked "adiabatic" gives the amount of power required assuming that no heat whatever is extracted from the gas during the process of compression. The curve marked "actual indicated horse power," gives the amount of indicated horse power in the cylinder of gas compressor required to compress one million cubic feet of free gas the stated number of compressions.

This power should be increased by the mechanical losses in the compressor (about 15 to 20 per cent.) in order to obtain the actual amount of power required to operate the compressor. The curve marked "efficiency" represents the ratio between the values represented by the "isothermal" curve and the "actual indicated horse power."

As an example, we will show how to figure the amount of power required to compress 1,000 cubic feet of free gas per minute from atmosphere up to 1,000 pounds pressure:

Absolute initial pressure of gas = 14.65 lbs.
Absolute discharge pressure = 1,000 + 14.65 = 1014.65 lbs.

$$\text{Number of compressions} = \frac{1014.65}{14.65} = 78.3 \text{ atmospheres.}$$

Considering that the number of compressions in each stage should be limited to about seven, we must use three stages for obtaining the above pressure, the number of compressions in each stage being about 4.3.

$$4.3 \times 4.3 \times 4.3 = 79.3.$$

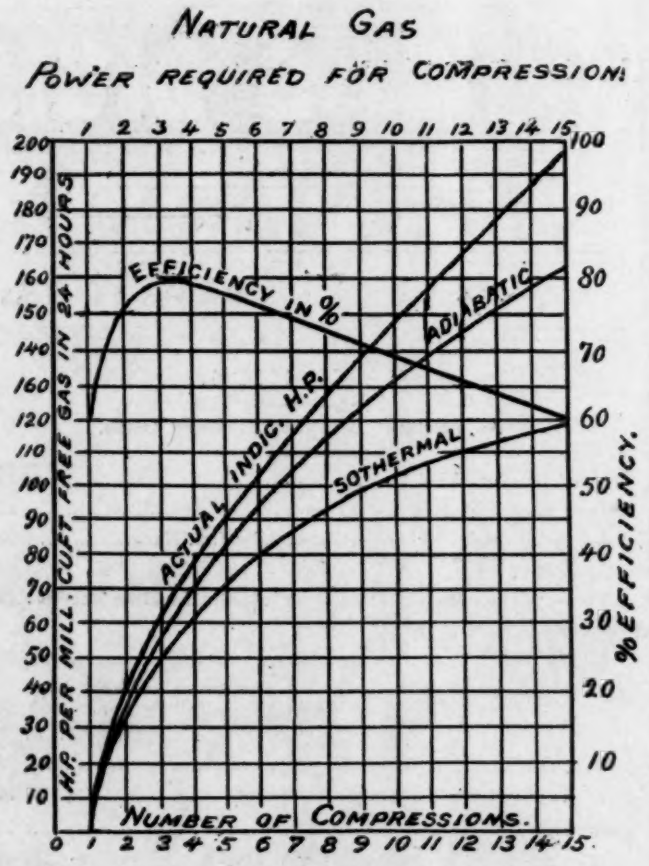
NATURAL GAS
POWER REQUIRED FOR COMPRESSION
H.P. PER MILL. CU.FT FREE GAS IN 24 HOURS
% EFFICIENCY.
NUMBER OF COMPRESSIONS.
EFFICIENCY IN %
ADIABATIC
ACTUAL INDIC. H.P.
ISOTHERMAL
INDICATED H.P. REQUIRED FOR COMPRESSION OF 1 MILL. CUFT FREE GAS IN 24 h.
AND EFF. OF COMPR. IN % OF ISOTHERMAL.

Fig. 1.

From the curve we find that 4.3 compressions require about 82-horse power per million cubic feet of free gas in 24 hours = 1,440 minutes. 82-horse power × 3 stages = 246 indicated horse power in the compressor for the 3 stage compression.

Assuming a mechanical efficiency of 82 per cent. of the compressor, the power required will not exceed $\frac{246}{.82}$ = 300-horse power per million cubic feet. 1,000 cubic feet per minute, 1,000 × 1,440 = 1.44 millions in 24 hours, will therefore require 300 × 1.44 = 432-horse power.

As you extract certain of the consti tuents by condensation in each state, the power required for the next stage will of course decrease as the volume of the gas is reduced.

The various fractions herein referred to have not been thoroughly analysized as to calorific value and candle power, but apparently they seem to perform about the same duty. The air mixture and combustion, of course, varies. Roughly, from a standpoint of commercial opinion, with proper adjustment of the burners, they seem to give about the same value of service pound for pound, while their candle power, in a photometric standpoint, averages very closely 25 candle power. The distribution of these fractious, as has been intended by the inventors and developers of the process, is to the effect that these fractions compressed at a low temperature should be used in warmer climates and under conditions of the highest temperature; while the fractions under a higher pressure should, as far as possible, be distributed in districts of lower tem perature and higher altitude.

Again we revert to the initial paragraph of this article, namely, the use to which Liquid Gas should be placed. It must be remembered that about 80 per cent. of our entire population live in communities of less than 5,000 population. Such communities do not justify the installation and maintenance of an isolated gas plant, with its attendant burden of fixed charges, depreciation and overhead expenses. The possibilities being a supply to several similar communities from some center of distribution or base. The disappearance of

our wood fuel, as for instance in the Southern farming communities, will shortly necessitate some method of conveying and storing fuel in an economical, condensed, convenient and safe form. The necessity for gas range and other appliances in the rural communities are really greater than those of the city, where the distribution of coal and the collecting of ashes is more efficiently handled. Hence, the desire will be for a compact, efficient and economical fuel in tabloid form, condensing the maximum amount of latent heat into a cartridge of minimum weight and bulk.

The compressed B.T.U.'s contained in these "Liquid Gas" fractions represent a concentrated and portable heating service, and, as previously explained, the fact that this is a fuel rather than an explosive, is of paramount consideration, affording safety in transportation and operation.

Comparison of Thermal Values.

	Heat Units per Cubic Foot at 32° F. (Low Value).
Liquified natural gas	2,000 to 3,000
(Different compositions for various uses.)	
Blaugas	1,800
Ethyl alcohol	1.570
Acetylene	1,500
Pintsch gas	1,100
Natural gas of good quality	1,000
Marsh gas (methane)	960
City gas	600
Water gas (uncarbureted)	300
Producer gas	150

It will be seen by the above that 1 cubic foot of liquified natural gas is equivalent to about 8 cubic feet of water gas, 4 cubic feet of city gas, or varying quantities of the other gases.

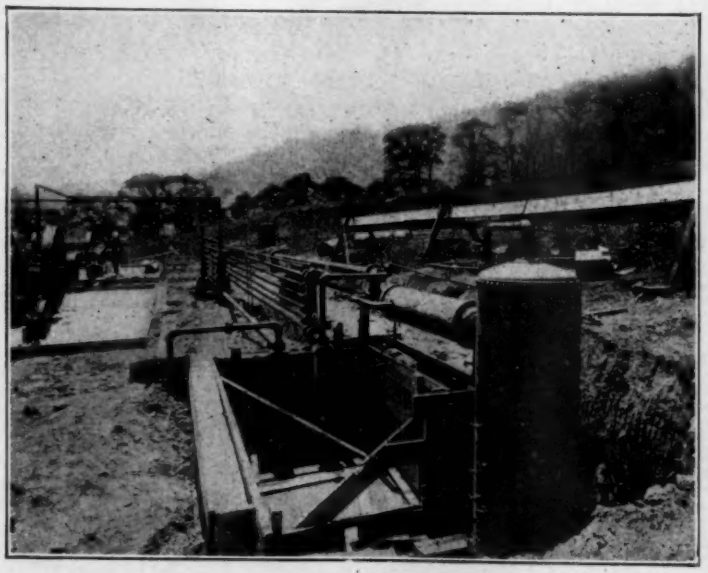

Fig. 2.—Accumulator or Receiver Tanks of a Plant for Extraction of Gasoline. The Gasoline Fractions Collected from Gas as are received in these Accumulator Tanks.

(To be Continued.)

Illinois Standards of Service for Gas and Electric Utilities.

These rules prepared by Mr. S. P. Farwell, Chief of Service Dept., and Mr. A. S. B. Little, Gas Engineer, under the direction of Mr. Robert M. Feustel, Chief Engineer; have been adopted by the Illinois Commission, effective November 1st.:

General Service Rules.

Rule 1. *Records and Reports.*—All records required by these rules shall be preserved for at least 3 years after they are made. Such records shall be kept within the State at an office or offices of the utility located in the territory served by it and shall be open for examination by the commission or its representative. Each utility shall notify the commission of the office or offices at which the various classes of records are kept and shall file with the commission such reports as the commission may from time to time require.

Rule 2. *Testing Facilities.*—(a) Each utility shall, unless specifically excused by the commission, provide such laboratory, meter-testing shop, and other equipment and facilities as may be necessary to make the tests required by these rules or other orders of the commission. The apparatus and equipment so provided shall be at all times available for the inspection or use of any member or authorized representative of the commission.

(b) Each utility shall make such tests as are prescribed under these rules with such frequency and in such manner and at such places as may be approved by the commission.

Rule 3. *Request Tests.*—Each utility furnishing metered service shall make a test of the accuracy of any meter upon written request by a consumer: *Provided*, first, that the meter in question has not been tested by the utility or by the commission within 6 months previous to such request and second. that the consumer will agree to accept the result of the test made by the utility as determining the basis for settling the difference claimed. No charge shall be made to the consumer for any such test. A report giving the result of every such test shall be made to the consumer.

Rule 4. *Adjustment of Bills for Meter Error.*—If on any test of a service meter, either by the utility or by the commission, such meter shall be found to have a percentage of error greater than that allowed in Rule 11 (c) for gas meters, or Rule 22 (e) for watt-hour meters, the following provisions for the adjustment of bills shall be observed:

(a) *Fast Meters.*—If the meter is faster than allowable, the utility shall refund to the consumer a percentage of the amount of his bills for the 6 months previous to the test or for the time the meter was installed, not exceeding 6 months, corresponding to the percentage of error of the meter. No part of a minimum, service, or demand charge need be refunded.

(b) *Slow Meters.*—If the meter is found not to register or to run slow, the utility may render a bill to the consumer for the estimated consumption during the preceding 6 months, not covered by bills previously rendered. but such action shall be taken only in cases of substantial importance where the utility is not at fault for allowing the incorrect meter to be in service.

Rule 5. *Record of Tests and of Meters.*—(a) *Service Test Record.*—A complete record of the quality and condition of service shall be kept by each utility. The record so kept shall contain complete information concerning each test, including the date and hour when and the place where the test was made, the name of the inspector conducting the test, the result of the test and such other information as may be required by these rules, or as the Commission may from time to time direct, or as the utility making the test may deem desirable.

(b) *Meter Test Record.*—Whenever any service meter is tested, the original test record shall be preserved containing the information necessary for identifying the meter, the reason for making the test, the reading of the meter upon removal from service and the result of the test. together with all data taken at the time of the test, in sufficiently complete form to permit the convenient checking of the methods employed and the calculations.

(b) *Meter Record.*--A record shall also be kept, numerically arranged, giving for each meter owned or used by any utility, the date of purchase, its identification, and the repairs and tests to which it has been subjected, with dates and general results of all tests.

(c) *Tabulation of Meter Tests*—Monthly and annual tabulations of the results of all meter tests shall be made, arranged according to types of meters and intervals of test.

Rule 6. *Meeting Reading on Bills.*—Bills rendered periodically to consumers for meter service shall show the readings of the meter at the beginning and end of the period for which the bill is rendered, the number and kinds of units of service supplied, the dates of the meter readings and the price per unit of service. On all bills which are computed on any other basis than a definite charge per unit of service, the other factors used in computing the bill shall be clearly stated so that the account may be readily computed from the information appearing upon the bill.

Rule 7. *Complaints.*—Each utility shall make a written acknowledgement to the consumers of the receipt of all complaints; shall make a full and prompt investigation of all such complaints, and shall keep a record which shall show the name and address of the complaintant, the date and nature of the complaint, and the adjustment or disposal thereof.

Rule 8. *Interruptions of Service.*—Each utility shall make all reasonable efforts to eliminate interruptions of service and when such

interruptions occur shall endeavor to re-establish service with the shortest possible dely. Whenever the service is interrupted for the purpose of working on the distribution system or the station equipment, this shall be done at a time which will cause the least inconvenience to consumers and those most seriously affected by such interruptions shall, if possible, be notified in advance.

SPECIAL GAS SERVICE RULES.

RULE 9. *Definition of a Cubic Foot of Gas.*—For testing purposes, a cubic foot of gas shall be taken to be the amount of gas in a volume of one cubic foot when saturated with water vapor at 60° F., and at a pressure of 30 inches of mercury.

For purpose of measurement to a consumer, a cubic foot of gas shall be the amount of gas in a volume of 1 cubic foot under the conditions existing in such consumer's meter as and where installed; but, provided consumer's meter shall not be set so close to any source of artificial heat as to subject them to a temperature exceeding 75° F.

RULE 10. *Meter Testing Equipment.*—Each utility furnishing metered gas service shall own an approved meter prover of not less than 5 cubic feet capacity, and shall maintain the same in proper adjustment to register the accuracy of the meters to within one-half per cent. (½ per cent.). The meter prover shall be so placed as to be shielded from excessive temperature variations and shall be equipped with suitable thermometers and other necessary accessories.

The accuracy of all provers and methods of operating same may be established from time to time by a representative of the commission. All alterations, accidents, or repairs which might affect the accuracy of a prover or the method of operating same shall be promptly reported in writing to the commission.

RULE 11. *Gas Meter Accuracy.*—(a) *Method of Testing.*—All tests to determine the accuracy of registratration of a gas service meter shall be made with a suitable meter prover. At least two test runs shall be made on each meter, the results of which shall agree with each other within one-half per cent. (½ per cent.)

(b) *Installation Test.*—Every gas service meter, whether new, repaired, or removed from service for any cause, when installed for the use of any consumer, shall be in good order and shall have been adjusted to be not more than one per cent. (1 per cent.) in error when passing gas at six (6) cubic feet per hour per rated light capacity. Each such meter shall be marked by the utility testing it, with the date of the last test made on that meter.

(c) *Allowable Error.*—Whenever a meter is tested to determine the accuracy with which it has been registering in service, it may be considered as correct if found not more than two per cent. (2 per cent.) in error, and no adjustment of charge shall be entailed unless the error is greater than this amount.

(d) *Prepayment Meters.*—No utility shall use prepayment meters geared or set so as to cause a rate or amount higher than would be paid if a standard meter was in use, unless the consent of the commission is first obtained in writing.

RULE 12. *Periodic Tests of Gas Meters.*—No gas service meter hereafter installed shall be allowed to remain in service more than five years from the time when last tested without being retested as specified in Rule 10, and, if necessary, readjusted within 1 per cent. before being set for use.

During each period of 12 months after these rules take effect, until all meters now in service shall have been tested, each gas utility shall remove and test not less than 20 per cent. of all meters now in service, those longest in service being removed first.

RULE 13. *Referee Tests.*—Upon written application to the commission by a consumer a test will be made of said consumer's meter, as soon as practicable, by an inspector employed by the commission. The application for such test shall be accompanied by a remittance of the amount fixed below as the fee for such test. If the meter is found to be more than 2 per cent. fast, this fee shall be paid to the consumer by the utility.

The fees for referee meter tests are:

Not exceeding 10 lights capacity, each	$2.00
Exceeding 10 lights, but not exceeding 45 lights capacity, each	4.00
Exceeding 45 lights capacity, each	8.00

This rule shall not interfere with the practice of a utility in its tests of gas service meters, except that in the event of a written application to the commission by a consumer for a referee test, the utility shall not remove or interfere with said meter without the consent previously given in writing of the consumer.

RULE 14. *Calorimeter Equipment.*—Each utility whose gas output exceeds twenty million cubic feet per year shall equip itself with a complete standard calorimeter outfit of a type approved by the commission and shall test the heating value of gas supplied using methods of test in accordance with the best practice. The heating value of manufactured gas shall be determined on at least 3 days each week and of natural gas at least three times a year.

RULE 15. *Heating Value.*—Each utility furnishing manufactured gas shall supply gas which at any point at least 1 mile from the plant and tested in the place where it is consumed, shall have a monthly average total heating value of not less than 565 B. T. U. per cubic foot, and at no time shall the total heating value of the gas at such point be less than 530 B. T. U. per cubic foot.

To arrive at the monthly average total heating value of a gas, the results of all tests of total heating value made on the days prescribed for testing during the calender month shall be averaged, and the average of all such daily averages shall be taken as the monthly average.

Provided further than in case gas is carried by mains at 5 pounds pressure or over per square inch, there shall be an allowance in the service of such high pressure district of 35 B. T. U. per cubic foot in the monthly average, and the minimum heatiug value shall not fall below 520 B. T. U. per cubic foot. No utility shall lower its present standard heating value without first obtaining in writing the consent of the commission.

RULE 16. *Purity of Gas.*—(a) *Hydrogen Sulphide.*—Manufactured gas distributed in this State shall not contain more than 1 grain of hydrogen sulphide per 100 cubic feet. Any test approved by the commission may be used for the determination of hydrogen sulphide. This puriety requirement will be considered as satisfied if a strip of white filter paper recently moistened with a solution of 100 grains of lead acetate in 100 cubic centimeters of water be exposed to the gas for 1½ minutes in an apparatus previously purged, through which the gas is flowing at the rate of approximately 5 cubic feet per hour, the gas not impinging directly from a jet upon the test paper, and after this exposure the test paper be found not distinctly darker than a second paper freshly moistened with the solution and not exposed to the gas. Test papers shall be kept for one year by a safe and secure method, and shall be available to the commission if and when desired in that period.

(b) *Total Sulphur.*—Manufactured gas distributed in this State shall not contain more than 30 grains of total sulphur per 100 cubic feet.

(c) *Tests of Gas Purity.*—Each utility supplying manufactured gas shall for the purposes of record daily test the gas leaving the holders for the presence of hydrogen sulphide in the manner specified.

Each utility supplying manufactured gas whose sales exceed 50,000,000 cubic feet of gas per year shall provide and maintain such approved apparatus and facilities as are necessary for the detemination of total sulphur; and each utility shall daily determine the amount of total sulphur in the gas distributed by it.

RULE 17. *Pressure of Gas.*—(a) *Pressure Variation.*—The pressure of gas supplied by any utility as measured at the outlet of any consumer's meter shall not be less than 2 inches nor more than 8 inches of water pressure, except where greater pressure is specified and provided for in the contract between the utility and the consumer, and provided there be no unfair and unreasonable discrimination or preferences. Within said limits, the daily variation of pressure at the outlet of any one meter on the system shall never be greater than 100 per cent of the minimum pressure at that outlet, provided that variations in pressure entirely beyond the control of the utility shall not be considered as a violation of this rule.

(b) *Pressure Surveys.*—Each gas utility shall provide itself with one or more portable graphic recording pressure gauges and shall make frequent measurements of the gas pressure and of the pressure variation throughout the system.

RULE 18. *Record of Interruptions.*—Each utility shall keep a record of all interruptions to service on its entire system or on any portion thereof, which record shall contain the time, cause if known, extent and duration of the interruption.

RULE 19. *Extension of Mains.*—(a) *Definition.*—For the purpose of this rule a high pressure system shall be taken to mean one in which the gas is carried at a pressure of 2 pounds or over per square inch to the consumer's premises where a service governor is installed to obtain a reduced pressure on such premises. A low pressure system shall mean a system in which the consumer's service is

connected directly to a main carrying less han 2 pounds per square inch water pressure.

(b) *Free Extensions.*—Each utility shall, upon written request for service by a prospective consumer, or a group of prospective consumers located in the same neighborhood, make free of charge a street main extension necessary to give service provided that the length of the entire extension is not greater than that obtained by allowing 100 feet per consumer for a low pressure system and 200 feet per consumer for a high pressure system.

(c) *Extension Above Free Limit.*—If the main extension required to furnish service at any point within the corporate limits of any city or village, or for any adjacent suburb of a city or village, is greater than the free extension specified above, such an extension shall be made under the following conditions: The utility may require a deposit of the cost of the extension above the free limit and shall, in such a case, refund an amount equal to the cost of the free main extension for each additional consumer whose service shall be taken off of the entire extension within a period of 10 years from the making of such an extension, but at no time shall the rebate made exceed the original deposit. If the extension is of such length and the prospective business which may be developed by it is so meager as to make it doubtful whether the business from the extension would ever pay a fair return on the investment, the facts shall be reported to the commission for investigation and determination as to the reasonableness of such extension.

This rule shall not be construed as prohibiting any utility from making free extension of lengths greater than above specified or from providing a method of return of deposits for extensions more favorable to consumers so long as no discrimination is practiced between consumers whose service requirements are similar.

(d) *Contract for Service.*—Utilities will not be required to make street main extensions as described in this rule unless those served by such extensions shall contract to use the service for at least 1 year.

Special Electric Service Rules.

Rule 20. *Meter-Testing Equipment.*—(a) *Working Standards.*—Each utility furnishing metered electric service shall provide for and have available suitable and adequate facilities for testing its service watt-hour meters. These facilities shall be satisfactory to, and approved by, the commission, and shall, in general, include a test bench fitted with the necessary apparatus and such working standards as are needed. Such working standards will consist of portable indicating instruments and watt-hour meters known as "rotating standards." Working standards shall be calibrated periodically by reference to secondary standards of known accuracy, and shall either be maintained accurate to within one-half per cent. (½ per cent.) or the proper correction be applied to their readings.

(b) *Secondary Standards.*—Secondary standards of some approved type shall be owned and maintained by each utility having more than one thousand meters in service. Utilities not required to possess such secondary standards shall have their whole working standards tested and calibrated in any properly-equipped laboratory of recognized standing.

(c) *Check Meters.*—Utilities not required to possess secondary standards shall make the following provision for checking their rotating standards: For each kind (alternating or continuous current) of rotating standard a check meter of suitable type and capacity shall be provided, and the rotating standards shall be checked thereby at least once a week while in service. Such check meter may be of the service type, and shall be mounted permanently on the test bench. These meters shall be adjusted and sealed by an inspector of the commission, and shall be considered the reference standard for the utility. If this check shows the standard to be in error, it shall be calibrated in some laboratory of recognized standing.

(d) *Calibration Cards.*—Each working or secondary standard shall be at all times accompanied by a certificate, signed by the proper authority, giving the date it was last calibrated and the corrections to be applied.

Rule 21. *Meters: Method of Determining Average Error.*—The average error of a service watt-hour meter shall be determined as follows: The error at light load—here defined as approximately ten per cent. (10 per cent.) of the rated capacity of the meter—shall be determined by taking the average of at least two errors, determined from as many separate tests on the same light load, which error must agree within one-half per cent. (½ per cent.). The test runs shall be at least thirty seconds long.

In the same manner the error at heavy load—here defined as a load of approximately seventy-five per cent. (75 per cent.) of the rated capacity of the meter—shall be determined.

The average error of the meter shall then be determined by taking the average of the error at light load and the error at heavy load, proper account being taken of the sign of these two errors; provided, that where the consumer's connected load does not equal seventy-five per cent. (75 per cent.) of the rated capacity of the meter, the full connected load may be considered as heavy load for the purpose of test.

Rule 22. *Meter Accuracy.*—(a) *Creeping.*—No watt-hour meter which registers on "no load" when the applied voltage is less than one hundred and ten per cent. (110 per cent.) of standard service voltage shall be placed in service or allowed to remain in service.

(b) *Inspection and Test before Installation.*—No watt-hour meter shall be placed in service which is in any way mechanically defective or which has incorrect constants or which has not been tested for accuracy of measurement and adjusted, if necessary, to meet these requirements:

Average error not over 2 per cent.
Error at heavy load not over 1 per cent.
Error at light load not over 4 per cent.

(c) *Test for Correct Lagging.*—Alternating current service watt-hour meters which are to be used on circuits supplying inductive load shall also be tested before installation at one hundred per cent. (100 per cent.) of rated current at fifty per cent. (50 per cent.) lagging power factor and, if necessary, adjusted so that the error will not be more than two per cent.

(d) *Adjustment after Test.*—Whenever a test made by the utility or by the commission on a service watt-hour meter connected in its permanent position in place of service, shows that the average error is greater than that specified above, the meter shall be adjusted to bring the average error within the specified limits.

(e) *Allowable Error.*—A service watt-hour meter having an average error of not more than four per cent. (4 per cent.) may be considered as correct and no adjustment of charges shall be entailed by such an error.

Rule 23. *Meters: Installation Tests.*—(a) Each watt-hour meter shall be checked for correct connection, proper mechanical condition, suitability of location and accuracy of measurement in its permanent position in place of service within 60 days after installation.

(b) Meters operating on inductive circuits shall be tested on the connected load under conditions approximating as nearly as may be to heavy and light loads, as defined in Rule 21, and shall be adjusted, if necessary, so that the average error will not be more than two per cent.

(c) Meters installed with instrument transformers or shunts must be tested jointly with the transformers or shunts, otherwise the ratio of transformation of the transformers or the calibration of the shunts must be determined at least once every 5 years.

Rule 24. *Meters: Periodic Tests.*—Each watt-hour meter shall be tested according to the following schedule while connected in its permanent position in place of service:

(a) Two and three-wire commutating type and mercury type meters, up to and including fifty (50) amperes rated capacity of meter element, shall be tested at least once every eighteen (18) months.

(b) Two and three-wire commutating type and mercury type meters of over fifty (50) amperes rated capacity of meter element, shall be tested at least once every twelve (12) months.

(c) Two and three-wire single phase induction type meters up to and including twenty-five (25) amperes rated capacity of meter element, shall be tested at least once every thirty (30) months.

(d) Two and three-wire single phase induction type meters of over twenty-five (25) amperes rated capacity of meter element, shall be tested at least once every twenty-four (24) months.

(e) Self-contained polyphase meters up to and including fifty (50) kw. rated capacity, shall be tested at least once every eighteen (18) months.

(f) Self-contained polyphase meters of over fifty (50) kw. rated capacity, shall be tested at least once every twelve (12) months.

(g) Polyphase meters connected through current transformers, or current and potential transformers, to circuits up to and including fifty (50) kw. rated capacity, shall be tested at least once every twenty-four (24) months.

(h) Polyphase meters connected through current transformers, or current and potential transformers, to circuits of over fifty (50) kw. rated capacity, shall be tested at least every eighteen (18) months.

RULE 25. *Referee Test.*—Any service watt-hour meter will be tested by an inspector employed by the commission upon written application by the consumer. For such test a fee shall be forwarded to the commission by the consumer when making application, which fee shall be refunded to the consumer by the utility if the meter be found more than four (4) per cent. fast, the average error in measurement being calculated as specified in Rule 21.

The schedule of fees for referee tests of watt-hour meters is as follows:

(a) For continuous current and single phase meters operating on 600 volts or less, up to and including twenty-five (25) amperes rated capacity of the meter element, each.	$2.00
(b) For each additional fifty (50) amperes or fraction thereof..	.50
(c) For single phase meters above 600 volts, and for polyphase meters with or without instrument transformers, up to and including twenty-five (25) kw. rated capacity of the circuit.....	3.00
(d) For each additional twenty-five (25) kw. rated capacity, or fraction thereof.....	3.00

RULE 26. *Voltage Variation.*—Each utility supplying electrical energy from a constant potential system, shall adopt a standard service voltage for each locality supplied from such system, the suitability and adequacy of which voltage may be determined at any time by the commission and every reasonable effort shall be made by the use of proper equipment and operation to maintain such voltage practically constant at all times during which service is supplied. For service rendered under a lighting contract, or primarily for lighting purposes, the variations of voltage as measured at each consumer's cutout shall not exceed five (5) per cent., plus or minus, of the standard service voltage for that locality, for a longer period than 1 minute at each instance, at any time during which service is supplied. For service rendered under a power contract, or primarily for power purposes, voltage variations as measured at the service terminals shall not exceed ten per cent. (10 per cent.) plus or minus, of the standard service voltage for that locality for a longer period than 1 minute at each instance.

Variations of voltage in excess of those specified above caused by the operations of the consumer in violation of his contract or the rules of the utility, or from causes beyond the control of the utility, shall not be considered a violation of this rule.

RULE 27. *Voltage Surveys and Records.*—Each utility shall provide itself with one or more portable indicating voltmeters and each utility serving more than 250 consumers shall have one or more portable graphic recording voltmeters, these instruments to be of an approved type and having a range suited to the voltage supplied. Each utility shall make a sufficient number of voltage surveys to indicate the service furnished from each transformer and feeder, and to satisfy the commission of its compliance with the voltage requirements, and those having graphic voltmeters shall keep at least one of these instruments in continuous service at the plant, office, or some consumer's premises.

RULE 28. *Standard Frequency.*—Each utility supplying alternating current shall adopt a standard frequency, the suitability of which may be determined by the commission, and shall maintain this frequency within five per cent. (5 per cent.) plus or minus, of standard at all times during which service is supplied: Provided, however, that momentary variations of frequency of more than five per cent. (5 per cent.) which are clearly due to the lack of proper equipment or reasonable care on the part of the utility, shall not be considered a violation of this rule.

RULE 29. *Station Records.*—Each utility shall keep a station record which shall show: The time of starting and shutting down all generating units; the time of starting and disconnecting all street lighting circuits; the readings of such instruments at each generating station and at such intervals as are necessary to determine the character of the load; all interruptions to service affecting the busbars or distribution system, with the time, duration, extent and the cause, when known, of the interruption. An interruption is here defined, for the purpose of record only, as the interval of time during which the voltage falls below fifty per cent. (50 per cent.) of the standard voltage.

RULE 30. *Grounding of Secondaries.*—The rules contained in the current edition of the National Electrical Code regarding the grounding of secondaries shall be observed in all new construction. Each utility shall adopt a plan whereby existing construction shall be changed to conform to the rules as expeditiously as possible.

RULE 31. *Extension of Lines.*—(a) *Free Extensions.*—Each utility shall, upon written request for service by a prospective consumer or a group of prospective consumers located in the same neighborhood make free of charge a line extension necessary to give service and furnish free service connection, provided that such line extension does not require more than twice as many poles at standard spacing as there are individual applicants.

(b) *Extensions above Free Limit.*—If the line extension required in order to furnish service at any point within the corporate limits of any city or village, or for any adjacent suburb of a city or village, is greater than the free extension specified above, such an extension shall be made under the following conditions: The utility may require a deposit of the cost of the extension above the free limit and shall, in such a case, refund an amount equal to the cost of the free main extension for each additional consumer whose service shall be taken off of the entire extension within a period of 10 years from the making of such an extension, but at no time shall the rebate made exceed the original deposit. If the extension is of such length and the prospective business which may be developed by it is so meager as to make it doubtful whether the business from the extension would ever pay a fair return on the investment, the facts shall be reported to the commission fos investigation and determination as to the reasonableness of such extensions.

This rule shall not be construed as prohibiting any utility from making free extensions of lengths greater than above specified, or from providing a method of return of deposits for extensions more favorable to consumers so long as no discrimination is practiced between consumers whose service requirements are similar.

(c) *Contract for Service.*—Utilities will not be required to make line extensions as described in this rule unless those to be served by such extensions shall contract to use the service for at least one year.

Notes on the Design of Gas Condensers.

[Prepared by J. S. HAUG, for Meeting, Canadian Gas Association.]

Crude illuminating gas as it comes from the point of generation is a very complex substance, containing not only the gas, but many other substances, such as sulphur, ammonia, hydro-carbon vapors of so many kinds that scientists have only begun to classify them, free carbon, and large quantities of steam. The first step necessary in purifying the gas is to rid it of as many of its impurities as possible, and, at the same time, cool it to a temperature at which further purification is possible. This is the work of the condenser, and its design is subject to variations according to the temperature desired, the water supply, and the degree of economy in water that may be necessary.

There are several kinds of condensers but the only one which will be here considered is the water tube condenser with rivetted steel plate shell and vertical wrought iron or steel tubes. At one time there was considerable discussion as to the relative merits of the condenser with water outside the tubes, sometimes called the "multi-tubular" condenser, and the water tube condenser in which the gas is outside the tubes; but the latter has been almost universally adopted, and the other type can only be recommended when the condensing water is very clean and the gas so dirty that frequent cleaning of the gas space is necessary. For plants using dirty water the water tube condenser is the only practical one, since the tubes can be easily cleaned out, whereas the space around the tubes is very difficult to clean. The writer has seen condensers of the "multi-tubular" type which, when dismantled, proved to be more than half full of mud. One can imagine that in the last days such condensers were not very efficient.

The water tube condenser gives more cooling surface for the same number of tubes than the multi-tubular, since the cooling surface is that in contact with the gas, and in the water tube the outside area would be the effective cooling surface; whereas the cooling surface of the multi-tubular condenser is the inside area of the tube. The water tube construction also makes the outside shell available as gas cooling surface, whereas this is lost in the multi-tubular condenser. The water tube condenser is stronger for the same weight of material since the water pressure only comes on the lower portion of the shell where it is strongly reinforced by the bottom plate, angle iron, and tube sheet. The multi-tubular condenser on the other hand has to sustain the water pressure for practically its whole height.

The upkeep of the multi tubular condenser as regards painting is much more expensive, due to "sweating," occasioned by the condens-

ation of moisture in the air on the cold shell. In the case of the water tube condenser the shell is hot, and condensation, therefore, does not occur.

In the design of condensers the most important determination to make is the necessary amount of water cooling surface. The air cooling surface, while assisting to some extent, is so much less in quantity and efficiency that it need not be considered in the design. Cooling surface depends upon two things: first, the amount of heat to be transferred from the gas to the water; and second, the rate at which a given surface will transmit heat.

The first depends upon the difference between the temperature of the gas at the inlet of the condenser and the temperature which it is desired to maintain at the outlet, and on the condition of saturation of the gas and the liquid products to be condensed. Crude gas which has passed through a hydraulic main or wash-box may be assumed to be saturated as it comes to the condenser, and by far the greatest amount of heat which the gas contains at this point is the latent heat of vaporization of the steam contained in the gas, and the heat to be extracted from condensed water at gas inlet temperature to bring it to gas outlet temperature. There is also the heat of vaporization of the hydro-carbons condensed and heats abstracted from the gases themselves, but for practical purposes they need not be considered, especially as the air-cooling surface is not taken into account, and this would tend to compensate for any small error involved in neglecting minor quantities of heat.

To obtain the number of heat units to be extracted, the weight of water vapor in the gas at inlet temperature must be ascertained, and the weight of water vapor in the gas at outlet temperature deducted. The difference will be the weight of water condensed and this multiplied by the heat units lost per pound between the working temperatures will give the total amount of heat to be extracted. The inlet temperature should be determined as closely as possible, as a few degrees of temperature difference affects the results considerably. Variation in the outlet temperature does not affect the result so much. The next point to consider is the quantity of cooling surface necessary to transmit this heat, and this varies considerably with the temperatures involved, and the condition of the cooling surface whether clean or dirty. The heat transmitted per unit area, say per square foot of cooling surface, depends first on the difference in temperature on the two sides of the surface, which may be conveniently described as heat potential or heat differential. From tests made by the writer, a figure of approximately 6 B. T. U. per square foot was established for 30° heat potential and steel surface not absolutely clean, but in average working condition with some mud coating. To describe this unit further, it means that when the average difference between temperatures of gas and water in a condenser is in the neighborhood of 30° F., each square foot will transmit 6 B. T. U. per hour for every degree of temperature difference. Consequently if this difference is 25° a square foot will transmit 150 B. T. U. per hour. If the difference is 35° it will transmit 210 B. T. U. It must be borne in mind, however, that as the temperature differences decrease, the unit given will slowly decrease and *vice versa*. In other words, at high heat potential differences, the heat transference per degree is greater than at low heat potential differences, so judgment must be exercised and the constants should be used without modification only within limits. A certain amount of latitude is, however, permissible, due to errors unavoidably introduced by muddy water and variations in water temperature.

The number of tubes required depends on the diameter and length adopted. A 3-inch tube is a good working size. If much smaller it gives trouble more frequently with stoppage, and is not so easy to clean out. If one use a much larger tube, the heating surface per square foot of floor space is diminished without any compensating gain. A 20-foot length of tube works out well for condenser with vertical tubes, as it is structurally strong, is long enough to give good proportions, and does not require excessive head room. It is also not too long to be easily obtainable commercially. For very small condensers a shorter tube could be used.

The dimensions of a condenser, the cooling surface and size of tubes having been determined, are fixed by the spacing of the tubes, and this is something not subject to mathematical calculation but is more or less a question of experience and judgment. One would ordinarily space the tubes as closely together as possible to obtain the largest amount of cooling surface in a small condenser, but is limited in this by working conditions. A coal gas condenser especially is subject to stoppage by naphthalene mixed with tar, and it is important to so design the condenser that the spaces between the tubes are large enough to be accessible for cleaning, and also to make stoppages less frequent. The more room there is around the tubes, the more sludge is required to fill the space up, and, what is more important, the semi-liquid mass flows away to the seal pot more readily. For coal gas condensers a good working arrangement is when the tubes are spaced at such distances that they occupy about 18 per cent. of the total area of the tube sheet. For water gas, which is less liable to obstruction, 23 to 25 per cent. has given good results.

The condensor may be either cylinderical or rectangular. For condensers smaller than 10 feet diameter, the cylinderical shape is usually adopted, but a condenser larger than this can be made rectangular with advantages of floor space. Connections should always be made so that the water flows in the opposite direction to the flow of gas, thus preserving the maximum heat potential and ensuring the greatest heat exchange. For this reason two cylinderical condensers are often set in tandem, the gas going first through No. 1 and then through No. 2, while the water enters No. 2 close to the gas outlet, and leaves No. 1 close to the gas inlet. This principal can be extended in coal gas condensing, with great advantage, by making the overflow from the secondary condensers feed the primary condensers. By this means considerable economy in water consumption is effected, and at the same time a more uniform heat potential is maintained. With the primaries fed with warm water, the gas is not "shocked" so much as if both primaries and secondaries get cold water.

In the gas space of the condenser baffle plates should be placed, causing the gas to travel backward and forward across the tubes. By this means three advantages are obtained: first, the cooling surface is made more efficient by increasing the velocity of impingement; second, short circuiting or travelling from the inlet to the outlet, missing considerable surface, is prevented; and third, a scrubbing action is obtained, which helps to remove condensation at the temperature at which it condenses, which is a recognized principle in condensing. The amount of baffling is limited by the somewhat increasing liability to stoppage, but four or five passes in the length of the tube can be employed with advantage, and in large condensers there should be vertical divisions as well as horizontal baffles. These should be so arranged that the gas travels successively from the warmer to the cooler portions of the condenser, insuring efficient heat exchange, and the flow of water should be directed to pass gradually from the coolest to the warmest portion.

Provision should be made for cleaning the condenser, especially above the lower tube sheet, by having a sufficient number of hand holes. Manholes in the lower water space and gas space are also necessary. Inlet and outlet connections for gas are usually cast iron flanged pipes and will be ample in size if linear velocity of gas passing through them does not exceed 800 feet per minute. The size of water inlet depends upon the pressure in the supply main, and should be of such a size that the valve will be about 30 per cent. open when passing the maximum probable amount of water the condenser will use. The water overflow connections and connections from one condenser to another, when condensers are operated in tandem, should be designed so that the velocity of water in pipe does not exceed 200 feet per minute. The water compartment should be provided with drain valve at base of condenser so that it can be emptied when necessary. Tar overflows should be made of ample size to take condensation quickly away from the tube sheet, as this is the point at which stoppage in condensers commences.

In designing condensers, as with other pieces of apparatus, it must be remembered that the conditions under which they work are variable, particularly the temperature of the condensing water, which may vary from 84° F. in the summer to 34° in the winter. Consequently the condensers must be of sufficent size to perform their maximum duty under the most unfavorable circumstances. This condition will usually occur when the temperature of the condensing water is highest, in the latter part of the summer. It is then necessary, especially in the case of coal gas secondary condensers, to cool the gas almost to the temperature of the inlet water; consequently, as the temperature differential is so small the amount of heat transmitted per square foot of surface will be correspondingly low, and sufficient surface must be provided to transmit all the heat. When these conditions are properly met the capacity will be ample under all circumstances.

THE Continental Gas and Electric Corporation's extensive programme will be uninterrupted by the present financial condition, and the payment of dividends on common and preferred stock will not interfere with the extensions and additions now under way in the company. The construction budget for the next 6 months is $250,000, and the money available for this purpose, after all fixed charges and dividends are paid, is $300,000.

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NOTICE TO ADVERTISERS.

New Advertisements and changes of copy therefor should be in hand Wednesday noon of week prior to date of issue.

NEW YORK, MONDAY, OCTOBER 12, 1914.

[Official Notice.]

Transportation Arrangements, American Gas Institute Meeting.

For the convenience of those attending the New York meeting, the Transportation Committee have made arrangements for special train and car service as set forth herein. As only a limited number of cars will be carried it is essential that the railroads be notified well in advance as to the necessary equipment, and it is *important* that those desiring reservations should mail their requests *promptly* to the member of the Committee having charge of the special upon which reservation is requested.

Schedules.—Special Cars.

Chicago Special.—Pennsylvania Lines (Fort Wayne Route), Monday, October 19th; Train No. 8. Leave Chicago (Union Depot, Canal and Adams streets), 3:15 P.M.; arrive Pittsburgh, 5:40 A.M. To be attached to special train from Pittsburgh.

Post card requesting reservations should be addressed to Mr. John M. Morehead, Peoples Gas Light & Coke Co., Chicago, Ills.

St. Louis Special.—Vandalia and Pennsylvania Lines, Monday, October 19th; Train No. 26. Leave St. Louis (Union Station), 12:08 P.M.; Terre Haute, 4:52 P.M.; Indianapolis, 6:50 P.M.; Columbus, O., 12:35 A.M.; arrive Pittsburgh, 5:50 A.M. To be attached to special train from Pittsburgh.

Post card requesting reservations should be addressed to Mr. Donald MacArthur, Laclede Gas Light Co., St. Louis, Mo.

Cincinnati Special.—Pennsylvania Lines, Monday, October 19th; Train No. 8-26. Leave Cincinnati (Pearl and Butler streets), 9 P.M.; Columbus, O., 12:35 A.M.; arrive Pittsburgh, 5:50 A.M. To be attached to special train from Pittsburgh.

Post card requesting reservations should be addressed to Mr. J. E. Stacey, Stacey Manufacturing Co., Cincinnati, O.

Detroit-Toledo Special.—Michigan Central and Pennsylvania Lines, Monday, October 19th; Train No. 402. Leave Detroit (Michigan Central Station), 8:20 P.M.; Toledo, 10:35 P.M.; arrive Pittsburgh, 5:50 A.M. To be attached to special train from Pittsburgh.

Post card requesting reservations should be addressed to Mr. J. W. Batten, Detroit City Gas Co., Detroit, Mich.

Philadelphia Special.—Pennsylvania Railroad, Tuesday, October 20th. Leave Philadelphia, 3:36 P.M.; arrive New York, 5:38 P.M. Equipment; parlor cars to be attached to special train on arrival.

Post card requesting parlor car reservations should be addressed to Mr. John B. Klumpp, The U. G. I. Co., Philadelphia, Pa.

Pittsburgh Special.—Pennsylvania Railroad, Tuesday, October 20th. Leave Pittsburgh (Union Station) (Eastern time), 7:05 A.M.; Harrisburg, 1:04 P.M.; North Philadelphia, 3:36 P.M.; arrive New York 5:33 P.M. Special sleepers from Chicago, St. Louis, Detroit-Toledo and Cincinnati will be attached to this train at Pittsburgh.

Post card requesting reservations from Pittsburgh to New York on this train should be addressed to Mr. Joseph F. Guffey, Philadelphia Co., Pittsburgh, Pa.

B. J. Kellum,
Chairman Sub-Committee on Transportation.

BRIEFLY TOLD.

American Gas Institute Convention Arrangements.—The ninth annual meeting of the American Gas Institute will be held in New York, October 20, 21, 22 and 23, 1914. The lecture on the evening of Tuesday, October 20, and all of the regular sessions will be held in the Engineering Building, 29 West 39th street, between Fifth and Sixth avenues. The registration bureau and booths, from which will be distributed and in which can be deposited between sessions, copies of the convention reports and papers, will be on the ground floor, and the office of the Secretary will be on the 8th floor. The arrangements assure ample comfortable space under one roof for all sessions. Bulletin boards will be provided in each meeting place, upon which will be indicated the papers about to be, and being read in each of the four sessions, which will give members an opportunity to select papers in which they are particularly interested.

On Wednesday and Thursday a buffet luncheon will be served at a nominal charge in Room No. 1. This will tend to keep the members together and during the lunches an opportunity will be given for those in attendance to get together and renew old and make new acquaintanceships.

The Hotel Astor has been selected as Convention headquarters. In the north and east ballrooms, on Wednesday evening, will be held the reception to the present and past Presidents. This will be the principal social function of the convention, and there will be dancing for the guests. Admission will be by ticket only.

The main ballroom in which, on Thursday evening, the annual banquet will be held, is one of the finest banquet halls in America, and the fact that a dinner is provided by Messrs. Muschenheim is a sure guarantee that it will be of the best.

Theatre parties for the ladies will be arranged for Thursday evening, and they are cordially invited to come to the balcony of the banquet hall afterward if they so desire.

For those interested in golf arrangement has been made for the use of the Sleepy Hollow Country Club, at Scarborough-on-the Hudson, which is one of the most beautiful and exclusive country clubs in the Metropolitan District.

The tentative programme for the three days' session is as follows:

Wednesday, October 21, 10 A.M. to 12:30 P.M.

Institute Meeting—Auditorium.

Report of Board of Directors.
President's Address.
Committee Reports.
Other Institute Business.

Wednesday, October 21, 2 to 5:30 P.M.

Manufacturing Section—Auditorium.

Refractory Materials, by Herman Russell, Chairman.
Oil Tar Separation, Recovery and Disposal, by R. E. Wyant.
Coal Gas Residuals, Feld Process, by F. H. Wagner.
Operating Experiences under a Calorific Standard. Symposium.
Efficiency Relation Existing between Various Test Burners, Argand and Open Flame, by F. H. Gilpin.

Distribution Section—Room No. 2.

The Welding of High Pressure Mains, by J. D. Shattuck.
The Installation and Maintenance of Services, by R. B. Duncan.
The Installation, Repairing and Testing of Meters by a Small Company, by Charles Otten, Jr.
The Improvement of Distribution Employees, by C. E. Reinicker.

Thursday, October 22, 10 A.M. to 12:30 P.M.

Manufacturing Section—Auditorium.

The Year's Progress in Carbonization Methods, by E. L. Spencer, Chairman.
Carbonization in Bulk, Kopper's Ovens, by C. J. Ramsburg.
The Operation of Inclined Reterts, by Frank Huber.

Chemical Section—Room No. 911.

Gas Chemist's Hand Book, by W. H. Fulweiler.
An Electrical Process for Detarring Gas, by F. W. Steere.
A Method for the Determination of Hydrogen Sulphide in Gas, by A. B. Way.
A New Recording Calorimeter by C. H. Stone and W. H. Hinman.

Distribution Section—Room No. 2.

The Proper Specifications for, and Inspection of, Interior Gas Piping, by A. E. Turner.
Piping of Large Buildings for Gas, by O. H. Fogg, Chairman.
Utilization of Gas Appliances, by W. J. Serrill, Chairman.

Accounting Section—Room No. 3.

In Rate Fixing by Commission, Should Depreciation be Deducted from Plant Valuation, by A. C. Humphreys.
Accounting for Depreciation, by Harold Ericksen.

THURSDAY, OCTOBER 22, 2 to 5:30 P.M.

Manufacturing Section—Auditorium.

Methods and Facilities for Specifying and Testing Blowers, and Measuring Air and Steam Supply to Water Gas Generators, by J. M. Spitzglass.
Measurement of Gas in Large Volumes, by Dr. J. F. Wing, Chairman.
Purifier Installations, by C. E. Paige.
Care and Maintenance of Gas Holders, by J. H. Braine.

Chemical Section—Room No. 911.

Ammonia Purification, by V. von Starzenski.
The Fusibility of Ash in Coals Used in Gas Making, by Perry Barker.
The Mode of the Decomposition of Coal by Heat, by Dr. H. C. Porter.
Gas Manufacture from the Point of View of Physical Chemistry, by W. F. Rittman.

Illumination Section—Room No. 2.

Illumination by Gas, by C. O. Bond, Chairman.
The Physical Installation of Gas Arcs, by C. A. Luther.

Accounting Section—Room No. 2.

Compensation of Meter Readers, by H. C. Schaper.
Printing and the Care of Printed Stock, by W. P. Baylie.
An Extension of the Dewey Decimal Classification System to Gas Engineering, by D. S. Knauss.
Rate Making, by William McClelland, Chairman.

FRIDAY, OCTOBER 23, 10 A.M. to 12:30 P.M

Institute Meeting—Auditorium.

Unfinished Businesss.

EMPIRE STATE GAS AND ELECTRIC ASSOCIATION MEETING.—The 10th annual meeting of the Empire State Gas and Electric Association was in the United Engineering Societies Building, New York, on October 2d. After calling the meeting to order, President Hutchings outlined the activities of the Association during the preceding year, calling attention to the success in defeating the plan for State development of electricity from water power that had been proposed in the last Legislature; and the suggestions made by the Association for a program of development and utilization along the lines recommended by the water power committee of the National Conservation Congress. The organization of the Utilities Mutual Insurance Company, as a result of the enactment of the Workmen's Compensation Law, was referred to, and it was pointed out that while the company was not directly connected with the Association, it was made possible largely through the existence of our organization. Calling attention to the nitrogen filled lamp and other recent developments, Mr. Hutchings urged the members te use their efforts to push the sales of gas and electricity for purposes for which they were suitable, rather than attempt to get business where success was doubtful, or development had proved that other means for accomplishing the purpose were more satisfactory. The members were urged to assist the Executive Committee and to co-operate with it in all work that it might undertake, and also to use their efforts to increase the membership in the Association.

After the Treasurer had submitted the financial statement, Mr. C. G. Durfee read the report of the Electric Meter Committee. He called attention to the modification made during the year by the Public Service Commission of the Second District, in their order previously issued prohibiting the use of ampere hour meters; and described some new types of meters which were being developed and which it was expected would soon be on the market, with particular reference to inexpensive types of maximum-demand and intergrating watt meters. There was some discussion on this which developed the fact that many were waiting for a low price demand-meter in order to put new schedules of rates in effect.

Mr. H. L. Coleman read an instructive paper on gas rates. He pointed out that, with the usual straight line rate, a large percentage of the consumers do not pay the cost of service to them, and that the small number of large consumers are compelled to bear this burden. His position was that such a system of rates was discriminatory against the large consumer, and that from the company's standpoint it was unsatisfactory, as it penalized the profitable customers and prevented the greatest possible use of the service by all. He maintained that there are two classes of costs—first, the consumers cost, and second, the output cost—and favored a rate which contained a fixed charge sufficient to cover the consumers cost, with an additional charge for the actual gas used. He pointed out that a change from the old straight line rate to this method, while only requiring that each consumer pay his proper proportion of the costs, would effect substantial reductions to large customers, and an incentive to both large and small customers to increase the consumption, as the 1,000 foot price, after the payment of the fixed charge would be comparatively small. Such a system of charges, in his experience, had met with very general approval, and resulted in increased sales. The paper also dealt with the subject of special rates for special uses. Mr. Coleman's theory in this matter is that discrimination to be considered unjust must injure someone. Where differentials in price are based solely on quantity used, unjust discrimination is bound to result; but he does not consider that it is unjustly discriminatory to charge a baker a different price from that charged a dry goods store, as long as all bakers are charged alike and all dry goods stores alike. Numerous authorities were cited in defence of the further theory of competitive rates, and an analogy drawn between the rates for gas and freight rates. The plan of making class rates for special uses is favored as being absolutely necessary to secure a larger amount of profitable business, which will be a benefit to the company and to the community at large, because it would bear a portion of the fixed charges. The general conclusion of the paper is that a rate system containing a customers charge and a 1,000 foot charge, is a scientific and proper one; and that modifications of such a rate based on the use to which the service is put, and independent of the quantity of gas used, will result in advantage to all consumers and cannot be considered to be unjustly discriminatory. There was considerable discussion on this paper, and the concensus of opinion appeared to be that the straight line rates commonly used in the gas business are not scientific and are unsatisfactory, and that some method of a two-charge or three charge rate is desirable.

Following this discussion, the meeting adjourned for luncheon, at which representatives of 90 companies sat down.

At the opening of the afternoon session Mr. J. W. Lieb, Vice-President of the New York Edison Company, read an interesting paper on the incandescent lamp situation. Mr. Lieb reviewed the development of the incandescent lamp, mentioning the large number of low grade lamps which have been put on the market from time to time, and the necessity of the electric company keeping control of the lamp situation in order to render service which would be satisfactory to its customers. He cited four ways in which the lamp situation might be handled by a public service company. First: Furnishing of initial supply and renewals by the company without charge. Second: The supplying company charging a price just sufficient to cover the cost. Third: Charging list prices, thereby furnishing lamps at a profit. Fourth: The company not handling lamps in any way. Mr. Lieb discussed each of the methods and strongly urged that whatever method be adopted it was advisable for the company to keep control of the situation, as otherwise lamps would not be renewed as frequently as they should be, and many low efficiency lamps might find places on the circuit, which would injuriously affect the service received by tne consumer and for which the supplying company would be blamed. In the discussion of this paper, lead by Mr. R. M. Searle, Vice-President of the Rochester Railway and Light Company, all appeared to agree that the company should keep control of the situation; but there was some difference of opinion as to whether this could be done by the second or third method as well as by the first. The Secretary was instructed to communicate with the members of the Association and ask for a brief outline of the policy at present pursued, and the members opinion as to the best policy in case the one in force is not entirely satisfactory.

Mr. R. F. Whitney submitted a report for the Nominating Committee and the following officers for the new year were unanimously elected:

President—J. C. DeLong, Syracuse.
1st Vice-President—E. H. Palmer, Geneva.
2d Vice-President—Stuart Wilder, Mount Vernon.
Treasurer—H. W. Peck, Schenectady,
Secretary—C. H. B. Chapin, New York city.
Executive Committee—H. M. Beugler, Poughkeepsie; G. M. Cole, Plattsburgh; C. H. Graf, Albany; C. A. Graves, Walton; W. R. Huntley, Buffalo; S. J. Magee, Ithaca; A. B. Tenney, Oswego; C. G. M. Thomas, Long Island City; and J. I. Hutchings, Rochester.

CITIES CO-OPERATION.—Director of Public Works Cooke, of Philadelphia, announced that the Mayors of 90 cities have accepted the invitation to attend a conference in November, for the purpose of discussing the relations between municipalities and public service corporations. He says:

"Philadelphia proposes simply to open a discussion, and stands for nothing but intercity co-operation. Up to the present there has been practically no co-operative action by American cities. The drift in recent years has been toward State regulation, the public service corporations working in favor of such regulation. In so doing, they have apparently been largely influenced by a desire to avoid the inconsistencies inherent in local regulation. In the far west there are reasons to believe that they are emerging from a period of unqualified State regulation, toward State regulation tempered by home rule, and in some places to a type of home rule that leads ultimately to municipal ownership.

"As a State, Pennsylvania is just beginning to work out a policy. Up to the passage of the recent Public Service Act we had almost no local regulation and the operations in the utility companies were untempered to any great extent as they have been in some States, by the menace of public ownership. The passage of our Utilities Act was in response to a demand that something be done. There are many critics of the act as passed, but the decisions rendered under it have been so few up to date as not to give any general idea of how the act properly enforced will operate."

The Wholesale Distribution and Measurement of Gas.

[Prepared by Mr. J. D. Hackstaff, for Twenty-Second Convention, Pacific Coast Gas Association.]

The gas industry is at present in the midst of an evolution in its basic methods of doing business. It is losing many of the characteristics which have made it unique among business enterprises. Owing to the fact that nearly all of its invested capital was definitely fixed and buried in the ground, and that any change in operating conditions entailed practically the abandonment of a considerable portion of the plant, there has been engendered a conservatism which until recent years has permeated the business.

The average coal retort of to-day is almost identical in shape and setting with those installed a hundred years ago. We wash and purify our gas in apparatus designed in our grandfathers' day. The conventional method of distribution by the weight of the holder, through cast-iron pipes, is identical with that used in London before the Battle of Waterloo. The tin meter in every cellar and the rotary station meter were with us before the recollection of our oldest members. In fact, until recently, a coal gas plant in a small town might easily have been built from the drawings and specifications of an English plant of 60 years ago, and still be, to all intents and purposes, an up-to-date plant. Truly these devices are most ingenious and perform their functions very satisfactorily; I know of no other machine which, like a gas meter, can be relegated to a damp cellar and left without attention for years, and still be relied upon for accurate work.

It is not so strange, therefore, that in transmitting and distributing gas, there has been little or no progress along fundamental lines, no radical departure from the practices of our forefathers. Gas plants, as a rule, are of slow growth; not evolved over night, and in consequence those in charge have been bound down by the heritage from their predecessors. It was not within their province to develop new principles. Such conduct might entail consigning a goodly portion of the plant to the scrap heap, and in the gas industry, as opposed to the steel industry, the scrap heap does not exist. We are all familiar with the small plant, built of cast-off and out-grown units of the more prosperous works. The manager was handed something to run—it was put up to him to operate what he had and save pennies—not to revolutionize the industry and perhaps make dollars.

We have, therefore, continued to use cast-iron mains with lead or cement joints. When our systems expanded and it became necessary, in order to maintain the pressure in outlying districts, to transport more gas through the old lines, we installed, at enormous expense, cast-iron feeders, or sometimes, as an alternative, built district holders to be filled during the off-hours, and often without regard to the æsthetic side of life, planted them in the heart of first-class residential property. This, of course, did not add to the popularity of our companies with the public. If our business still increased we loaded our holders with scrap iron to get a few additional inches of pressure, and finally employed a fan booster to tide over the peak hours. It is recorded that one ambitious superintendent even put 2 Sturtevant fans in tandem in order to obtain sufficient "tenths" to serve his customers. As an indication of the conservatism of the gas engineer, when one of the largest companies in New York built a new plant on Long Island a few years ago, it dug a tunnel under the East River, and installed 2 4-foot cast iron mains to operate at 1-pound pressure.

Under these limitations from the expense of large mains, and the apparent inability to tranport gas any great distance by any other means, the gas industry was necessarily a local affair. Each locality had to have its plant which manufactured and retailed gas in its immediate vicinity. There was no tendency, as in other lines of business, to centralize manufacture in large efficient units and from thence send out the product for retail distribution. Our electric friends reached this state of development before they were hardly out of their swaddling clothes. In the artificial gas industry the idea is of comparatively recent origin. So, in the eighties, we find it the established practice for each locality to have its own manufacturing plant retailing its entire product to consumers in the neighborhood by means of holder pressure, and through cast-iron mains. Natural gas was a development of the petroleum industry, at first a by-product, and it was in the hands of men unacquainted with artificial gas traditions and technique. These men used screw pipe to handle oil, and therefore used it to transport gas. They produced the gas under high pressure at considerable distances from their markets and therefore utilized the pressure at hand to transport it to the consumers. From motives of economy they used small pipo and consequently had to carry high pressures on their distributing system. At first they throttled the pressure at the consumers appliance through a cracked valve. Afterwards, of necessity, they developed the regulator to automatically perform the same function and placed it on the service. As the regulator did not always work, and high pressures are destructive to tin meters, they made a meter with a cast-iron case. As the business expanded the producer with his trunk lines reached the borders of cities already supplied by a manufactured gas system. Logically, arrangements were made to distribute the natural gas through the existing mains, either by the trunk line owner purrhasing the local company, or morc often wholesaling his product at the city limits. As the old cast-iron mains could not be used for pressures over 6 or 8 ounces, regulators and reducing stations were installed at the outskirts of the city to drop the main line pressure to that figure. Thus, at an early stage in the natural gas development, we find one producing or pipe line company, transporting gas at high pressures to several localities and wholesaling it to the local distributing companies, who in turn retailed it to the consumers. It was soon discovered that the artificial gridiron fed from a single point was inadequate for the heavy consumption of gas during the winter months for domestic heating. To overcome this difficulty, and to escape the risks attending the transporting of very high pressures through city streets, a medium pressure feeder was extended from the reducing station at the outskirts of the city to the district needing an additional supply, to feed into the low pressure system through regulators. From this has been developed the present method of adopting existing low pressure artificial plants for the distribution of natural gas. The high pressure trunk line conveys the gas to a main regulating and measuring station near the city limits. From thence a so-called belt line, carrying from 10 to 30 pounds, extends into and around the portion of the city having the heaviest load, with branches to the outlying districts. Whenever possible, this belt line is made a closed loop so as to reduce the liability of interruption of service. It is usually laid out through the industrial district, passing the large industrial consumers supplied directly from it through individual regulators. Wherever possible the branches from the main belt line are tied together or looped back into it so that every district regulator is fed from two directions. Many managers of artificial gas companies saw the advantages of such a distributing system, but until the last few years most have refrained from using more than the 3 or 4 pounds pressure which could be secured from a positive pressure blower. Mr. Cowdery developed for St. Louis along these lines what he called his "Ideal distributing system."

About the time that this combination high and low pressure distribution system was developed for natural gas, falling rock pressures coupled with increased consumption brought about the use of compressors to enlarge the capacity of existing trunk lines. When this was first contemplated the idea met with considerable opposition and even ridicule. It was argued that as gas was an electric medium it would act a good deal like an india rubber plug, and instead of flowing through the line would pile up to such great pressure that it would burst the pipe. These objections seemed so vital that one of the largest natural gas companies instead of using a compressor plant installed a large exhauster at the town end of a 36-inch line into Pittsburgh to suck the gas into town. As might have been expected the exhauster did not increase the total carrying capacity of the line. After accelerating the gas for an hour or so until it had removed the pack at the lower end of the line, it had no further appreciable effect than to decrease the total quantity delivered by the amount of fuel required to operate it. This will be apparent to any one who appreciates the fact that the flow of gas through any given line varies as the square root of the difference of the squares of the initial and final pressures.

$$Q \text{ varies as } \sqrt{P_1^2 - P_2^2}$$

A number of engineers of artificial gas companies, pursuing the same thought, have installed exhausters at district holders, believing that their operation would greatly increase the capacity of the feeder trunks, whereas their only true function is to place the gas in the holder against its throw. Following the adoption of compressers on the natural gas trunk lines, it was demonstrated by experiments made, largely by members of this Association, that compressed artificial gas has no material effect on its calorific or candle power. The Pacific Coast also deserves the credit of being the pioneers in the commercial application of these discoveries and in the installation of

high pressure distribution lines for manufactured gas. Coincident with the use of high pressures for wholesale transmission has been developed the systems for high pressure distribution of artificial gas with individual house regulators. This is clearly a reversion to the original practice of the natural gas companies. From this resume it is apparent that at present the practice of both the artificial and natural gas fraternities, although starting from diametrically opposite extremes, have not only met but in the case just mentioned have been completely reversed. Each has adopted the best points of the other, so that a gas engineer, in designing a new plant, rehabilitating an old one or figuring on extensions, has choice of a variety of methods and can adopt the one, or combination, which best suits the requirements of his particular problem.

Owing to the facility with which the oil gas process lends itself to central station design, and the advance of the by-product oven as the ultimate source of our gas supply in the regions depending on coal gas, it is evident that the present trend of development is toward the installation of large manufacturing plants and the distribution of gas from thence under high pressure to localities where it is to be retailed. At these points it will be distributed to the consumer either through individual house regulators, or through a low pressure system; the method employed depending upon the density of the consumers and the preference and conservatism of the engineer.

In the design of high pressure distributing lines, the size of the pipe and the pressure to be carried are matters of engineering computation and compromise; the higher the pressure, the smaller the pipe. In determining which is most efficient we must balance any saving of fixed charges due to the use of smaller size pipe, against increased charges and higher operating costs at the compressor. It must also consider that although the installation must be sufficient to care for the load during the peak hours, interest and depreciation run 24 hours each day.

Economy and efficiency demand that the managers of both the wholesale and distributing companies unite their best efforts to minimize the effect of peaks and to distribute the load as evenly as possible throughout the 24 hours. This result can most easily be accomplished by the judicious handling of the retailers' holders, which are especially valuable if their capacity is a large percentage of the daily consumption. Under such conditions, if the holders are kept floating on the line absorbing the excess flow during the light hours, and giving up gas to the consumer during the peaks, the load curve on the transmission line may be kept fairly uniform. This becomes especially important when the ultimate carrying capacity of a transmission line is called upon to supply the insatiable demands of the consumers for gas.

The line construction adopted for high pressure work will depend upon the character of the gas and size of the line. Cast iron mains, with lead or cement joints, usually give considerable trouble if operated at a pressure over a pound, unless each joint is fitted with a leak clamp. Although screw pipe up to 6″ may be laid with reasonable certainty that it will remain tight, larger sizes as a rule give considerable trouble, and it has been found in natural gas work almost impossible to keep 10″ and 12″ screw lines from leaking. For these reasons it is the almost invariable practice to use plain end casing with slip couplings.

Within the last 2 years paranite has succeeded rubber as a gasketting material, owing to its superior resistance to the solvent action of gasoline. It is still a question, however, whether paranite will withstand the drip liquors of manufactured gas. Pacific Coast companies are using asbestos gaskets with oil gas for some years with fairly good results; the oil carried along with the gas lubricating the gaskets and filling any air cracks. Asbestos gaskets for natural gas have been condemned in the East, and experience on the Midway line have been unsatisfactory, they having dried out and become hard. The discovery of a gasket of good material that can be used with artificial and natural gas is of extreme importance and is attracting the attention of investigators. The practice of welding pipe into a continuous line may be the final solution of the problem.

The correct measurement of large quantities of gas at high pressure is an interesting problem. Recording meters should be installed at all important initial, branch and terminal points, so that an accurate check may be kept on the amount of gas passed; not only to show the quantity used by each consumer, but also to determine the characteristics of the load curve and the amount of unaccounted for gas on each division of the system.

Any arrangement by which settlement between the trunk line and the distributing company is made upon a percentage of the gross readings of the retail meters, is fundamentally wrong. At the start this seemed to be a simple solution of the problem; but the burden of the town leakage is thrown upon the pipe line company, and the local company has no incentive to keep its distributing plant in shape. In consequence of this the unaccounted-for gas in many towns have been from 50 to 100 per cent. of the readings of the consumers meters. For the proper operation of any wholesale gas system means must be provided to measure the gas at the origin of the line (whether a gas field or a central manufacturing plant) and at each point of wholesale delivery. There are three types of measuring devices available: The Volumetric; the Dynametric; the Thermometric.

In the Volumetric type either all or a known proportion of the gas is measured by a positive displacement meter. In this class are the rotary and the proportional meters. The proportional meters of Westinghouse, Wylie and Wescott, shunt off a definite proportion of the flowing gas through a positive displacement meter known as the "tally," and multiply the amount measured by the ratio between the main and the diverted stream, the reliability of measurement depending upon the stability of the ratio between the two streams of gas. With clean gas at nearly constant pressure the rate of flow does not vary greatly, and these meters give results fairly consistent. They are used by all natural gas companies, and measure practically all the gas delivered to industrial consumers at low pressures. If, however, the gas contains dust, or dirty oil or water, their delicate proportional valves become clogged and registration is liable to be incorrect. For important work two should be set in tandem, or checked every few days against a meter of a different type. Their great advantage is that they definitely register the gas, and the amount passed may be read directly from the dial. Any other type requires some mathematical calculation to obtain the quantity.

In the Dynametric type the velocity with which the gas passes an orifice of known area is determined and the quantity delivered calculated. In this class are the Venturi Meter, Pitot Tube and Orifice Flange. The Venturi Meter is not at present used on high pressure natural gas. The Pitot Tube and Orifice Flange are identical in their fundamental principles, based on the elementary equation that

$$\text{Quantity} = \text{area} \times \text{velocity},$$

and

$$\text{Velocity} = \sqrt{2\,g\,h}$$

in which g is the acceleration due to gravity of 32.2; h the dynamic head of the flowing fluid in feet; and v the velocity in feet per second.

In the Pitot Tube gas is caused to flow through a smooth tube of sufficient length to secure perfectly parallel flow, a tip is inserted in the tube pointing against the direction of the current and attached to a water column so that it measures the dynamic head due to the velocity of the flowing gas. The Orifice Flange is a restricting orifice in a diaphragm inserted in the pipe; the static pressure on each side of the orifice being measured and the difference between them gives the head necessary to produce the flow through the orifice. In the Pitot Tube we measure the difference between the static and dynamic pressures due to the velocity of the flowing gas; in the Orifice Flange we measure the difference between the static pressures on opposite sides of an orifice. In the first we measure the effect of the velocity; in the second, its cause. In both cases the differential measured is a function of h in the formula $V = \sqrt{2\,g\,h}$.

For a Pitot Tube h is the head equivalent to the difference between the static and dynamic pressures, or in other words, head due to the velocity of the gas flowing.

For an orifice flange h is head equivalent to pressures on inlet and outlet side of orifice or head causing the flow of the gas.

When any fluid, gaseous or liquid, flows through a tube or orifice, the actual area of the moving column is not the same as the interior cross section of the passage through which it flows, nor do all the particles of the flowing stream move with the same velocity. The retardation of the particles in contact with the metal, due to skin friction, cause eddy currents and varying velocities at different distances from the circumference. These variables affect the actual cross section of the flowing stream, which is the area expressed in the above equation by A, and also prevent the positive determination of the exact mean velocity V. In any instrument the relation between the actual size of the opening and the mathematical area A, and between the observed velocity and the mean velocity V, are expressed by a coefficient C. It is evident that in Pitot Tube or Orifice Flange the value of this coefficient is a function of that particular piece of apparatus. It can only be determined accurately by calibration against some known measuring device such as a gasometer, ori-

fice prover, or standard tube or flange, whose constant is known. Until recently it was the custom to calibrate tubes or orifices with gas flowing at pressures near that of the atmosphere, thinking that the behavior at other pressures (other densities) would vary inversely as the square root of the density, and that the coefficient C would therefore remain constant for any given gas. This assumption has been proved to be erroneous, without doubt because of the varying physical characteristics of the gas at different densities affecting the skin friction and eddy currents. It must be remembered that gas at 300 pounds is 20 times as dense as the same gas at atmospheric pressure.

As the mathematical functions which express these varying physical conditions are highly complex, and not as yet completely understood, it is necessary to resort to tests to determine their effects. The tube or orifice must be calibrated at various pressures and various rates of flow, and the values of C obtained plotted to determine mean values to cover average conditions. Our formula, therefore, for any given instrument

$$Q = C\sqrt{2gh}$$
$$Q \quad C\sqrt{h}$$

Where h is the height of the column of the gas as flowing necessary to give the mean velocity observed.

The second member of this equation is made up of two parts, the co-efficient C and the radical $\sqrt{h}$. The co-efficient C is constant for any given instrument measuring a gas inside of certain definite determinable limits of density and rate of flow. Once determined, it is used as a multiplier and does not enter into the recorded observations. The radical $\sqrt{h}$ varies with the amount measured, and is the quantity which in some form or other must be noted by the observer or registered on the recording charts. In all the mathematical transformations of these observations necessary to determine from them the number of cubic feet of gas passed it is evident that if any factor should appear which will remain constant at all readings it may be removed from under the radical and made part of the coefficient. This will tend to simplify the calculations required to secure the final answer.

As the usual method of measuring the dynamic head is by means of a water column, and the h in the above formula is expressed in terms of the height of the column of the gas flowing, it is necessary to convert, inches of water, H, into feet of flowing gas, as follows:

H = inches of water observed.

$\frac{H}{12}$ = feet of water.

W = weight of cubic foot of water (62.355 pounds at 62° F.)

w = weight of cubic feet of gas flowing.

$$\therefore h \cdot w = \frac{H}{12} \cdot W$$

$$h = \frac{\frac{H}{12} \cdot W}{w}$$

$$h = \frac{W}{12} \cdot H\,\frac{1}{w}$$

Although Q in the formula is originally expressed in cubic feet per second the quantity passing during any desired period of time or number of seconds N can be shown by multiplying the second number of the fundamental equation by N.

Therefore in measuring any definite gas the actual displacement of the flowing gas passing through the instrument in time N is as follows:

$$Qn = N \cdot C \cdot \sqrt{\frac{W}{12}} \cdot \sqrt{H} \cdot \sqrt{\frac{1}{w}}$$

$$Qn = Coeff \cdot \sqrt{H} \cdot \sqrt{\frac{1}{w}}$$

The weight w, of each cubic foot of the flowing gas is subject to variations from three causes:

1. Variation due to change in the specific gravity, G.
2. Variation due to changes in static pressure under which it is measured; or its observed flow pressure, P.
3. Variations in the temperature at which it is measured; or its observed flow temperature, T.

As these variations are absolutely independent, it is permissible to assume that two of them are constant and that only the one under discussion is subject to change. Specific gravity, G, is a function of the physical composition of the gas. If we are dealing with a known fixed gas, as is usually the case, G can be treated as a constant, and can therefore be placed with the other constants in the final composition of the coefficient.

In calibrating any tube to determine its co-efficient, the specific gravity G, of the gas used is known. Thereafter, if used to measure gases of other gravities, a compensating correction factor must be applied to the coefficient. Any change in the specific gravity will directly affect the density or weight of one cubic foot of gas, *i. e.*

$$\text{Since } Qn = \text{co-efficient.} \sqrt{H} \cdot \sqrt{\frac{1}{w}}$$

and w varies as G

$$\therefore Qn \text{ varies as co-efficient.} \sqrt{\frac{1}{G}}$$

If C is the co-efficient determined with gas of specific gravity G, and c is the co-efficient desired for gas of some other specific gravity g

$$\text{then } C : c : : \sqrt{\frac{1}{g}} : \sqrt{\frac{1}{G}}$$

$$\text{and } c = C \cdot \sqrt{\frac{G}{g}}$$

$$\text{and } Qn = \sqrt{\frac{G}{g}} \cdot \text{Co-efficient} \cdot \sqrt{H} \cdot \sqrt{\frac{1}{w}}$$

Since the specific gravity of any commercial gas is not usually subject to wide or frequent variations, it is necessary to make only one correction of the co-efficient, and it can be used as long as the specific gravity remains unchanged.

The flowing pressure and temperature, however. are not functions of the composition of the gas, but must be observed at sufficiently frequent intervals to secure a mean result for the calculations. Pressure is usually measured on a gauge in pounds, P, above the atmosphere; and temperature, T, in degrees Fahrenheit. In all computations where comparisons of the effects of varying pressures and temperatures are sought, it is necessary to reduce these observed readings to some standard absolute base. Pressure is referred to a perfect vacuum. As the atmospheric pressure at sea level is approximately 14.7 pounds we add that to our gauge readings to obtain the absolute flow pressure, P_1, used in the computation.

$$P_1 = P + 14.7$$

Likewise, since zero of the Fahrenheit scale is 460° above absolute zero we add that to our thermometric readings to obtain absolute temperature T_1

$$T_1 = T + 460°$$

In the measurement of any substance as elusive and changeable as gas, it is necessary to have a standard unit of measurement to which all measurements can be referred. This unit is the mass contained in some given unit of volume at standard condition of pressure and temperature..

Volume—The cubic foot is universally used.

Temperature—60° F., or 520° absolute has been generally adopted

Pressure—There is some variation in practice, but a common base to which all others may be reduced is the average atmospheric pressure at sea level of 14.7 lbs. absolute.

These standard conditions of pressure and temperature are known as the pressure and temperature of storage. A cubic foot of any fixed gas under these storage conditions has a definite mass, a known and determined weight, expressed by d, and a fixed number of heat units. If the gas be measured in any instrument at these standard conditions, since w = d, the equation is

$$Qn = \text{co-efficient.} \sqrt{H} \cdot \sqrt{\frac{1}{d}}$$

Any departure in pressure and temperature from these conditions affects the mass of gas contained in a given volume.

Mass varies directly as the absolute pressure;
Mass varies inversely as the absolute temperature.

Since pressure and temperature are independent, let us assume that the temperature of the flowing gas remains at the standard and the pressure alone varies.

d = weight of cubic foot of gas at storage conditions, *i. e.* 14.7 lbs. absolute and 520° absolute.

w = weight of cubic foot of gas at flowing conditions, *i. e.* P + 14.7 lbs. absolute and T + 460° absolute.

$$w : d : : P + 14.7 : 14.7 \text{ and}$$

$$w = d \cdot \frac{P + 14.7}{14.7}$$

Likewise if we assume that the pressure remains constant at the standard conditions and the temperature varies, we have

$$w : d :: 520 : T + 460 \text{ and}$$

$$w = d. \frac{520}{T + 460}$$

If we assume that both the pressure and temperature vary we can combine these two equations when

$$w = d. \frac{P + 14.7}{14.7} \cdot \frac{520}{T + 460}$$

Consequently, if gas be measured at any known pressure and temperature the actual volumetric displacement of the gas flowing through the instrument in time N, will be

$$Qn = \text{Co-efficiant} \cdot \sqrt{H} \cdot \sqrt{\frac{1}{d}} \cdot \sqrt{\frac{14.7}{P + 14.7} \cdot \frac{T + 460}{520}}$$

Qn is expressed in terms of gas at the flowing pressure and temperature, and the final answer is desired in terms of gas at the storage temperature and pressure, Qs, therefore it is necessary to convert Qn to Qs.

Since the volume of a given quantity of gas varies inversely as the absolute pressure and directly as the absolute temperature,

$$Qs : Qn :: P + 14.7 : 14.7$$
$$:: 530 : T + 460$$

$$\therefore Qs = Qn \cdot \frac{P + 14.7}{14.7} \cdot \frac{520}{T + 460}$$

$$Qs = \text{Co-efficient} \cdot \sqrt{H} \cdot \sqrt{\frac{1}{d}} \cdot \sqrt{\frac{14.7}{P + 14.7} \cdot \frac{T + 460}{520} \left\{ \frac{P + 14.7}{14.7} \cdot \frac{520}{T + 460} \right\}}$$

Simplified

$$Qs = \text{Co efficient} \cdot \sqrt{H} \cdot \sqrt{\frac{1}{d}} \cdot \sqrt{\frac{P + 14.7}{14.7} \cdot \frac{520}{T + 460}}$$

The effect of the temperature factor $\sqrt{\frac{520}{T + 460}}$ is very slight, being only 1 per cent for every 10° variation from 60° F. It is evident, therefore, that when the mean flowing temperature of the gas can be kept near 60° this factor may be ignored.

Since in actual operation the mean specific gravity of the gas is usually nearly constant, the function $\sqrt{\frac{1}{d}}$ may be included in the co-efficient, likewise the atmospheric pressure 14.7.

Therefore the equation finally becomes

$$Qs = \text{Co-efficient} \cdot \sqrt{H} \cdot \sqrt{P + 14.7}$$

where H is the height of the observed water column in inches and P the observed gauge pressure in pounds.

A set of tables has been prepared which gives the arithmetical values of the factors $\sqrt{H} \cdot \sqrt{P + 14.7}$ for all values of H and P usually met in practice. With these and a value for the coefficient determined by calibration, the labor necessary to calculate the gas measured by a Pitot Tube or Orifice Flange is reduced to a minimum.

The greatest drawback in the use of either instrument in the past has been the requirement of constant attendance to make the observations. There are now, however, two makes of recording instruments which give reasonably good satisfaction, especially at pressures below 100 pounds. It is the opinion of many engineers that the orifice meter, properly calibrated and installed with recording devices, is the cheapest and most reliable means we have of measuring large quantities of high pressure gas.

The Thermometric type of meter measures the heat required to raise the temperature of the flowing gas a given number of degrees. The B.T.U.'s necessary to raise the temperature of a unit mass of gas a like amount being known, the amount of gas passed by the apparatus can be calculated. The Thomas meter, the only one of this type, is an ingenious and complex piece of apparatus, and shows great care and forethought put into its development. As the amount of heat required to raise a unit mass over any known range is independent of the pressure and temperature of the gas, this meter is able to disregard all consideration of variations in flowing pressure and temperature which are so much trouble in other types. It requires for its operation a continuous electric current, which is one of its limiting conditions. I refer you to the 1914 proceedings of the Natural Gas Association for a complete description of this instrument and its application.

This subject of wholesale gas measurement at high pressures is exceedingly complex. It is not a matter to be turned over to a mechanic or left in the hands of the average station operator, but it should be under the supervision and continual check of a trained technical engineer. There are so many chances for error that in the hands of untrained operators results are often valueless. In all cases the meter stations should be so arranged that checks can be had on the registration of whatever meters are used, and the checking should be done at stated intervals to prevent any error extending over too long a period of time.

Some Details of the Minneapolis Exhibition.

From a letter of the Chairman of the Exhibition Committee we take these interesting details:

In the Philadelphia hall there were 101 booths; in Madison Square Garden there were 130; at Minneapolis, 165 booths are provided.

The Industrial exhibits will be more in number and the booths larger than ever before; and the industrial fuel sessions will be arranged to accommodate 400. From present indications it appears that there will be at least 1,500 delegates in attendance, and the entertainment will be calculated on that basis. Mr. James J. Hill will welcome the delegates, as will also Mayor Nye, and Mr. T. N. McCarter will respond to the address of welcome. This will certainly make a strong opening for the convention.

From the standpoint of originality, this exhibition will be ahead of any ever held. In addition to the specially attractive features that will be carried out by the exhibitors, there will be a complete glass model of a gas works in which gas will be manufactured, by the Pittsburgh Coal Co. The Standard Oil Co., will show a miniature oil field with oil wells in operation. The Harley-Davidson Motorcycle Co., will exhibit a line of cycles equipped for carrying meters, for hurry-up service, and superintendents' motorcycles. The Wilcox Motor Co., will show automobile trucks equipped for carrying meters, etc. The Pillsbury Flour Mills Co., will have an exhibit and will mix dough to be baked in reel and portable ovens and gas range exhibits. The Addressograph Co., will show quick methods for addressing bills and envelopes, with their newest automatic machines. The Remington Typewriter Co., will supply free stenographic service, and there will be ample telephone and telegraph service in a convenient location.

The ladies will be given a beautifully appointed parlor 20 by 30 feet, a maid will be in attendance and everything will be done for their convenience. There will be a large well appointed cafe on the balcony where, during the noon hour, there will be a 15-piece orchestra and other entertainers. At night there will be a 28-piece military band.

The decorative scheme for the Armory, which is a wonderful exhibition hall, will be very elaborate. The Convention Hall is on the third floor, and is a beautiful large room, has an excellent floor and will be utilized on Monday night for the President's reception. This reception will gradually turn into a dance; and after the reception the members of the Association will have an opportunity of viewing the exhibition in its full dress. The public will not be admitted on Monday night, so this will give the members opportunity to have the exhibition to themselves.

The transportation committee has some novel plans for the entertainment of the members, both in Chicago and on the train en-route to Minneapolis.

Hotel reservations are coming in in large numbers, but the accomodations are adequate, so that everybody is going to be taken care of.

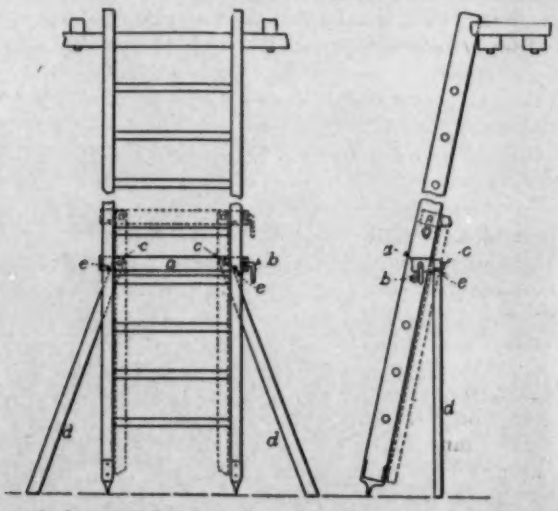
We have learned of two other important exhibits: a dummy window that will be dressed daily by the Window Dressing Committee, who, by the way, will also dress the windows of the Minneapolis Gas Light Company; and the exhibit of the Publicity Committee, who are collecting samples of newspaper copy, booklets, folders, gas bill stickers, circular letters, pamphlets, street-car cards, house organs, posters, etc.

This committee requests that every member send any and all advertising material that was prepared and used within the last two years. Send these immediately.

Address all display matter to Richard C. Fowler, Detroit City Gas Company, Detroit, Mich., and mark it for N. C. G. A. Show the industry what you are doing. Don't wait for something that is coming off the press next week. That can follow later. It is absolutely necessary that you get your advertising in to give them time to prepare this exhibit.

New Methods and Appliances.

LADDER SAFETY ATTACHMENT.—Everybody uses ladders, and they are large contributors to serious accidents. A simple attachment that will make a ladder absolutely safe if it is equipped with steel points is shown in the accompanying sketch. A piece of ⅝ by 1¼-inch



flat iron, *a*, is bent at right angles on each end to form a clamp and fastened to the ladder by a binding screw, *b*. Attached to the clamp *a*, by the bolts *c*, on which they swing, are two arms *d*. When these are pulled out against the stop pins *e*, they brace the ladder and prevent it from swaying. As the perpendicular distance from the floor to the bolts *c* is shorter than the props when pulled out, it is necessary in order to fold them back against the ladder to raise the clamp up and fasten it as shown by the dotted lines. The length of the arms should be one-third the height of the ladder.

FIRE TESTS OF A METAL-LATH WALL.—A 2½-inch solid metal-lath wall was erected in a fire-test house at Columbia University, New York city, and subjected to a temperature of 1,700° F., for 2½ hours. A 1½-inch stream of cold water at hydrant pressure (25 to 30 lbs.) was then directed against the partition for 2½ minutes. Neither the fire nor the water did sufficient injury to the wall to destroy its stability or fire-resisting quality. The wall tested was 14.5 by 9.5 feet high, the studding, 1-inch channel-iron weighing 0.76 lb. per lin. feet and set 12 inch c. to c. The lath was 24 gage expanded metal lath painted on both sides, weighing 3½ pounds per square yard. It was fastened to the studding with No. 18 annealed galvanized tie-wire. The first coat of plaster was 1 part Portland cement, $\frac{1}{10}$ hydrated lime and 2½ sand, by volume, with about 1 lb. of long cattle hair per cubic feet of cement. Two similar coats, omitting the hair, were then applied; and finally a coat of 1.2½ mix was put on.

The heat developed a number of cracks on the outside face of the wall within the first 10 minutes of the test. No cracks were noted on the inside during the first 1½ hours, when four cracks averaging about 2 feet in length appeared. After 2 hours 40 minutes the inner surface was covered with innumerable hair cracks extending in all directions, but the maximum opening was only $\frac{1}{16}$-inch deep.

The partition started to deflect inward almost immediately after the fire was started; the maximum deflection was $4\frac{3}{8}$ inch. After cooling the wall with water, the deflection was $2\frac{7}{8}$ inch. The application of water washed away a large part of the finish coat of plaster, and considerable of the second coat, but no metal was exposed. No fire, smoke or water went through the partition, and after it had dried out it was firm and gave a good ring when struck with a hammer.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 20 cents.

1,111,815. Apparatus for Automatic Gas Analysis. H. J. Westover, New York city.

1,111,939. Self Lighting Gas Lighter. O. R. Angell, Boston, Mass.

1,112,051. Oil Gas Producer. John, W. H. and M. M. Burdon, Bellshill, Scotland.

Items of Interest
FROM VARIOUS LOCALITIES.

IF the Portland (Ore.) Gas and Coke Company will surrender its franchise and permit the present commission of the city of Portland to issue another, Governor West believes the company would fare better than to take the matter up at the next session of the Legislature. The gas company secured its franchise from the State over 60 years ago, and the city has no authority over the company. The charter can be revoked only by the action of the Legislature, but since the representatives of the people over the State at large have no interest in the matter, Governor West has replied to Mayor Albee, of Portland, that the matter might be settled more satisfactorily if the company would deal only with the people concerned.

THIS is from a San Diego, Cal., daily: Mr. Thurston Owens, Secretary of the San Diego Gas and Electric Appliance Company, has been elected President of the San Diego Electrical League. Mr. Owens is a newcomer in San Diego, and his election should dispel any idea that it is necessary for one to be a "native son" to obtain recognition. Mr. Owens was formerly Manager of the La Crosse, Wis., Gas and Electric Company and has been in the Public Utility business for 15 years. He is the Local Secretary of the Illuminating Engineering Society, a Son of "Jove" and a member of several gas and electric associations. He is also a frequent contributor to the technical press.

EMPLOYEES of the Consumers Gas Company, Toronto, Canada, have organized a rifle association. Nearly 300 joined at the first meeting and a large proportion of the 1,700 employees are expected to enroll at succeedings meetings. Mr. Arthur Hewitt, General Manager of the company, in an address, advised young men who have no one depending upon them to join the militia. He was applauded when he stated that the company is paying to the families the salaries of the large number of employees who are now on active service in the Canadian contingent, and that the men who return will be given their old positions. Mr. G. W. Allen, Advertising Manager of the company, conducted the organization of the association, and the members were sworn in by Mr. W. C. Shaw.

AFTER many delays the plant of the Corpus Christi (Tex.) Gas Company has been completed and gas has been turned into the mains. The franchise of the company required that the plant be in operation and gas furnished all applicants by September 28. The company is incorporated under Texas laws with a capital stock of $300,000. Henry M. Wallace, owner of the gas plants at Waxahachie and Temple, is President and principle stockholder of the company.

MONTAGUE FERRY, City Commissioner of Public Service, Chicago, Ills., has written a letter to the City Council, containing recommendations for decreasing the price of gas. The letter concerns the rules laid down by the State Utility Commission, which permit the Peoples Gas Light and Coke Company to reduce the heat units from 600 to 565. He says, "The gas company can make this gas at a lower cost. The cheaper gas could be sold for 60 cents, or even 50 cents and give the company a profit." "Mr. Ferry's statements are ridiculous," said James F. Meagher, President of the gas company. "And his suggestion that we could make a profit on 60-cent or 50 cent gas is absolutely funny. At any rate, we do not contemplate reducing the quality of our gas nor changing the price."

T. M. R. MEIKLEHAM, of New York city, a director in the Atlantic Gas and Electric Company, states that the failure of that company will have no effect on any of the operating companies, among which is the Pennsylvania Utilities Company, which controls the electric and gas business in Easton, Bangor, Pen Argyl, Nazareth, Sayre, Portland, Pa.; Phillipsburg and Dover, N. J.

MR. R. E. SLADE, retiring manager of the New Orleans Gas Light Company has been appointed engineer of the Providence, R. I., Gas Company, effective November 1.

OHIO courts have held invalid the bonds issued by the municipality of Orrville, O., for the erection of a municipal plant in that town which is served by the Massillon Gas and Electric Company, a subsidiary of the Cities Service Company. The bonds, aggregating $42,000, were issued by a vote of the people, but is is held by the

courts that the Ohio laws in regard to issue of bonds for acquiring an existing electric plant were not followed. The city officials sold the bonds to a Pittsburg bank and paid out the proceeds on contracts, but the courts held this to be in contempt and fines were assessed against the city officials by the court. As the bonds have been sold and the proceeds paid to the city there is good prospect for further litigation between the purchaser and the city.

"W. B.," WRITING from Nanticoke, Pa., says, "The repairs well under way by the Luzerne County Gas Company, made necessary by damage done by the underground fire, will represent a goodly sum before they are completed, but the plant will be much improved as a result. So badly damaged were the brick walls that it was deemed best to rebuild the entire structure, which is quite an undertaking since the making of gas must in no way be interferred with. One of the improvements which will work to good advantage is the new siding, where coal cars will be unloaded with less trouble and expense than formerly.

THE Salina (Kas.) Light, Power and Gas Company is contemplating improving its gas service in the west part of the city. Work will commence soon on a 10-inch gas main from the plant on North Third street to Bishop and Ninth streets, where it will connect with the old mains. The pipe has been ordered and the work will commence as soon as the material arrives.

"L." SENDS this from Fairfield, Ia.: "There has been marked improvement lately in the gas service of the Fairfield Public Service Company. If the company will keep up this good work it will get into the good graces of the people of Fairfield again and they may be willing to aid it in making improvements which it considers necessary."

OFFICIALS of the Anderson (S. C.) Gas Company say that business conditions just at this time may be bad with some people, but this does not apply to the gas company. They are doing more business than they have done at any time since the enterprise was launched, and it is almost impossible for them to keep up with new business.

LOGAN, UTAH, city Commissioners have received a petition for a gas franchise presented by D. H. Gustaveson, A. M. Smith and Charles Reese. The commission instructed the recorder to notify the petitioners that action on the petition will be taken as soon as they are prepared to give evidence of their good faith. Some time ago other parties asked for a franchise and it was granted with numerous extensions of time, and finally a bond in the sum of $1,000 was asked as a guarantee. The bond has expired and can be declared forfeited at any time, and the Commission has decided to take no more notice of petitions that do not give evidence of a desire to build something.

HERE is a letter received by a newspaper in a Massachusetts town:

Sir—It is all very well to ask small manufacturers to keep their men on half work, to "carry on," but there is another aspect to be faced. I have just received the 7 days' notice to pay my account net—losing the 5 per cent discount. Now, if the Gas Committee are going to enforce this rule in such an arbitrary fashion I shall have to protect myself, and that will mean closing my works and throwing my men out of work. Surely, if the moratorium is to be of any use, the Gas Committee could meet consumers by arranging for payment—say by taking half the account this month and the other half next—without reducing the discount. I am being held up for cash remittances from abroad through Continental bankers actually refusing to remit their customers' accounts simply because their directors are Germans, who are sticking to all the cash they can lay hold of. I think that the committee should bear all these circumstances in mind in getting in accounts. Yours, etc., Small Manufacturer.

MR. W. W. LYMAN, Superintendent of the Binghamton, N. Y., Gas Works, was married on October 1st, to Miss Gladys Estelle Latimer, of Montville, Conn.

EACH year the books and accounts of the Boston Consolidated Gas Company are audited for the purpose of ascertaining the cost of gas in conformity with the provision of the legislative act relating to the sliding scale of gas prices. The audit for the year ended June 30, 1914, shows average costs of gas per 1,000 feet in comparison with the 6 previous years as follows (in cents):

Cost.	1914.	1913.	1912.	1911.	1910.	1909.	1908.
Gas made	30.14	24.95	22.73	23.27	23.53	29.87	31.47
Gas bought	29.95	29.89	29.89	29.93	30.10	30.50	30.45
Gas made and bought	30.04	27.38	25.97	26.22	26.41	30.16	30.96
Gas sold	31.06	28.31	26.89	27.13	27.22	30.99	32.63
Distrib. and gen. exp.	21.46	20.56	21.36	22.01	21.35	21.73	23.01
Tot. cost (exc. int. dep. & re.)	52.52	48.87	48.25	49.14	48.57	52.72	55.64

The amount of gas made, purchased and sold in cubic feet in the past 7 years compares as follows (000,000 omitted):

	1914.	1913.	1912.	1911.	910.	1909.	1908.
Made	3,140	3,094	3,157	3,052	2,917	2,634	2,395
Bought	3,153	2,996	2,612	2,425	2,274	2,270	2,361
Total	6,293	6,090	5,771	5,477	5,191	4,904	4,756
Gas sold	6,086	5,891	5,574	5,294	5,037	4,773	4,512

THE Maryland Public Service Commission may be forced to repeat the recent conference on standards for purity and heating values of gas, as the result of the resignation of C. E. Bowerman, the chief stenographer. According to Chairman Towers, Mr. Bowerman has dictated only a portion of the notes of the hearing into the recording graphophone and has served notice that if the commission desires him to complete the work he will have to be paid the regular price received by court stenographers. About 500 pages of the record have not yet been transcribed, and this work would cost at least $250. The commission is in a dilemma because the stenographer is not only in possession of the notes, but no other employee is able to read the notes even if they were available. "We don't propose to be held up," said Commissioner Timanus, "and, if necessary, we will hold the hearing all over again rather than submit to an exorbitant charge."

THE alterations to the office of the North Adams (Mass.) Gas Light Company are now complete and the convenience to the public and patrons of the company is greatly enhanced. Manager Cook's private office, which was formerly in the rear of the counting room, has been moved to the front of the office, making it much more convenient for people who wish to see him.

THE Springfield (Mass.) *Republican* says: "The war has had its effect in Springfield by causing the Springfield Gas Light Company to buy English made equipment instead of German for the changes to be made in its gas retorts. The German material could not be secured, so the English had the field to themselves. These retorts are the new smokeless and dustless retorts which are going to mean a spotless town in the region of Court Square and the municipal group, which under the old equipment was frequently thick with dust and smoke. The new retorts will do away with this trouble, requiring no open fires and no escaping steam or smoke.

A NEW HAVEN, Conn., society note says that Mrs. G. B. Scott, chairman of the household economics department of the New Haven Woman's Club, announced their first meeting for October 16, at 3 P M., in the building of the New Haven Gas Light Company. A model kitchen has been fitted up, and the meetings will be held there through the year. Mrs. A. B. Morrell, of Wallingford, who gave such an interesting demonstration before the department last year, will demonstrate a menu for a luncheon at the next meeting, and will give a demonstration at each meeting of the department.

MR. JAMES CADMAN, for several years in the New Business Department of the Waterbury (Conn.) Gas Light Company, will go to Philadelphia, in order to resume his connection with the United Gas Improvement Company.

MANAGER KIRKPATRICK of the Holyoke (Mass.) Gas and Electric Department, reports that arrangements have been completed for the demonstrations to be given in the city hall auditorium October 26, to show advantages to be obtained by using gas for cooking. All the space allotted for dealers to exhibit their goods has been taken, and starting Oct. 27, Miss Caroline P. Weber will deliver a series of free cooking lectures with demonstrations.

AMONG the noticeable improvements in the financial district of Brooklyn, N. Y., is the imposing seven story general office building of the Brooklyn Union Gas Company, on Remsen street. It is on a plot 75 by 100 feet, adjoining the old office of the company. The old building is to be converted into showrooms for domestic appliances and lighting fixtures.

Utilities Commission News.

NOT FORMALLY AUTHORIZED.—By failing to vote affirmatively on the specific proposition of establishing a municipal lighting plant the village of Spencerport, Monroe County, N. Y., has failed to come within the provisions of Section 241 of the Village Law, and the up-State Public Service Commission has been compelled to refuse its request for authority for a proposed electric plant for street lighting and general purposes. It appeared that the village at a recent election voted on two propositions, one to raise $16,000 for a light plant by a bond issue, and the other to expend $16,000 thus raised for such a plant. No proposition was voted on specifically to establish such a plant.

CHARGE FOR SHORT TIME INSTALLATIONS.—Upon the ground that a gas company is entitled, in addition to the charge for gas, to charge for installating and removing the service pipe in temporary homes at summer resorts, the New Jersey Board of Public Utilities Commissioners has handed down a decision partly favoring a proposed amendment to the rates of the Standard Gas Company of Monmouth County. The proposed new rates were to apply to Keansburg and Raritan township, Monmouth County, sections populated largely by summer tenants. The proposed rule was that every person who secured a meter for a tent, portable house, temporary shack or apartments of 3 rooms or less, must pay a yearly charge of $5 in addition to the regular charge for gas. The board says it will permit the company to file a rule for the collection of the extra $5 for the laying of a service pipe where the general indications are that such service pipe may not be in use more than one season. If a service pipe laid under such conditions, after the first year is continued in use, no additional similar charge is to be made.

TO REDUCE OVERCHARGE COMPLAINTS.—At Lincoln, Neb., the city council passed an ordinance which, if observed by the citizens, will reduce complaints of over-charge for gas and electricity, and at the same time show the consumers that they are paying only for the service they receive. The ordinance states that users of gas and electricity shall post a white card near the meter so that when it is read the reading can be marked upon it by the employee of the company.

The city council did not make it possible to imprison any one for not obeying the ordinance, nor did they provide a fine. The penalty is supposed to act automatically. The self-acting penalty is as follows: "Any consumer who shall refuse or fail to comply with the requirements of section 1, shall have no cause for action or complaint against the producer in case of any disagreement as to the readings of such meter."

While the ordinance is not generally obeyed it was stated that its purpose was to make the producers of current or gas furnish the readings if a consumer wants them. Inasmuch as the ordinance does not fix a penalty which the police department is required to enforce, the people will be left to their own discretion as to whether or not they neglect the duty prescribed by the council.

WORKMEN'S COMPENSATION.—To establish and regulate the liability of public service and other labor-employing corporations of the State, the last general assembly of West Virginia passed what is known as the Workmen's Compensation Act—really a section of the Public Service Commission Act—and up to June 30 it had been in operation 9 months. Each corporation is required to pay into the fund an amount depending on its pay roll, from which the claims for accident and death are paid. In that time a permanent partial disability pension roll of 47 claims, amounting to $1,103.56 per month; a permanent total disability pension roll of 11 claims, amounting to $256.96 per month, and a pension roll covering 201 fatal cases, with 465 beneficiaries, amounting to $5,078 per month, were passed on and allowed. The total amount paid out each month by the commission is $6,437.56, or $77,250.72 per year.

NEW JERSEY RULING ON SWITCHES.—In the matter of the complaint of Joseph H. McBride against the Public Service Electric Company, the State Board of Public Utility Commissioners, observing that there is a growing tendency to consider that the public utility companies should bear all the cost of bringing their service to the property line of the customer, decided that the defendant company was not required to provide the service switch and cut-out. The board held that wiring inside of a building is a part of the building.

Financial Notes.

IN conjunction with the receivership of the Buffalo (N. Y.) Gas Company, a bondholders' protective committee has been formed. There are more than $5,000,000 of the company's bonds outstanding. A. A. Jackson, Vice-President of the Girard Trust Company, Philadelphia, is a member of the committee.

THE last quarterly dividend paid on Massachusetts Gas Companies common stock was distributed among the largest number of stockholders in the history of the company, namely 4,797, an increase of 733 since the rate was increased from a 4 per cent. to a 5 per cent. basis in June, 1913. The number of common stockholders on July 15 last represents an increase of 439, or 10 per cent. over a year ago, and is treble the number 7 years ago. At the present time the average holding of common stock is 52 shares, compared with 179 in 1906.

The following table shows the increase in number of common stockholders since 1906, with average holdings:

	1914.	1913.	1910.	1908.	1906.
Common stockholders.....	4,797	4,338	3,180	2,748	1,392
Average holdings.....	52	57	78	90	179

There were 6,918 preferred stockholders on May 15 when last semi-annual dividend was paid, a new high record, comparing with 6,750 a year ago, and 6,486 four years ago. During the past year over 500 preferred shares were purchased for the account of 643 employees of the Boston Consolidated Gas Co., through the operation of the profit-sharing plan.

FOLLOWING the receivership for the Atlantic (Pa.) Gas and Electric Company, default has occurred in the semi-annual interest on the $1,880,000 first and refunding mortgage bonds of the Eastern Pennsylvania Power Company, one of the principal subsidiaries. Coincident with the announcement of the default, it was made known that Lee, Higginson & Co., of New York, who were the principal promoters of the power company would purchase the October interest coupon, if presented prior to January 1, 1915. The Company has until that date to make good the default.

THE Northern California Power Co., which serves the territory north of the Pacific Gas and Electric territory, reports gross earnings for seven months ended July 31, of $487,000, an increase of $38,000 as compared with 1913. In 4 years the gross earnings have increased 89 per cent.

THE New York Public Service Commission has an application from the Brooklyn Borough Gas Company for permission to issue $125,000 capital stock, for the purpose of repaying expenditures made from earnings. The company operates in Coney Island and other parts of the 31st Ward, and is one of the smallest gas corporations in Brooklyn and the first to reduce its capital at the suggestion of the commission some time ago. Last year was the first time it had paid a dividend.

JUDGE H. A. MATHEWS has signed an order enjoining the Macon (Ga.) Gas Company from increasing its capital stock above $500,000, as the company had petitioned the Georgia Railroad Commission for permission to do. The order is based on decisions in parallel cases, in which it has been held that where the charter of a company limits the amount of stock to be issued, that figure cannot be passed if a single stockholder objects, no matter what may be the reason or motive influenceing the object. In this case the objecting stockholder is S. J. Dannenberg, of Macon, owner of a small amount of stock, he contended that it would be detrimental to his interest for the capital stock of the company to be increased, while the gas company charged that he had secured the stock for the purpose of embarassing the company and forcing them to pay him a premium for it. The court was also asked to dissolve the holding company which controls the public utilities companies of Macon, and also to declare the election of the present officials of the Macon Gas Company null and void. The court has not yet passed on these features of the case.

THE Citizens Gas Company, of Indianapolis, Ind., has applied to the Indiana State Commission for permission to issue not to exceed $200,009 one-year collateral notes and bonds in the sum of $414,000 as collateral. Extensions of service and other expenses of the company, which have been taken care of from the income account of the company from time to time and which the company now desires to capitalize, make the petition necessary, it is pointed out. The bonds are not to be for sale at this time, but are to be used as collateral, it is declared. At the same time officers of the Indianapolis Gas Company, now leased by the Citizens Company, asked for authority to issue and deliver to the Citizens Company $142,000 of its mortgage bonds, dated October 1, 1902, and due in 1952, on the demand of the Citizens Company for extensions in the plant of the leased [illegible] egating made by the lessee. [illegible] held by the